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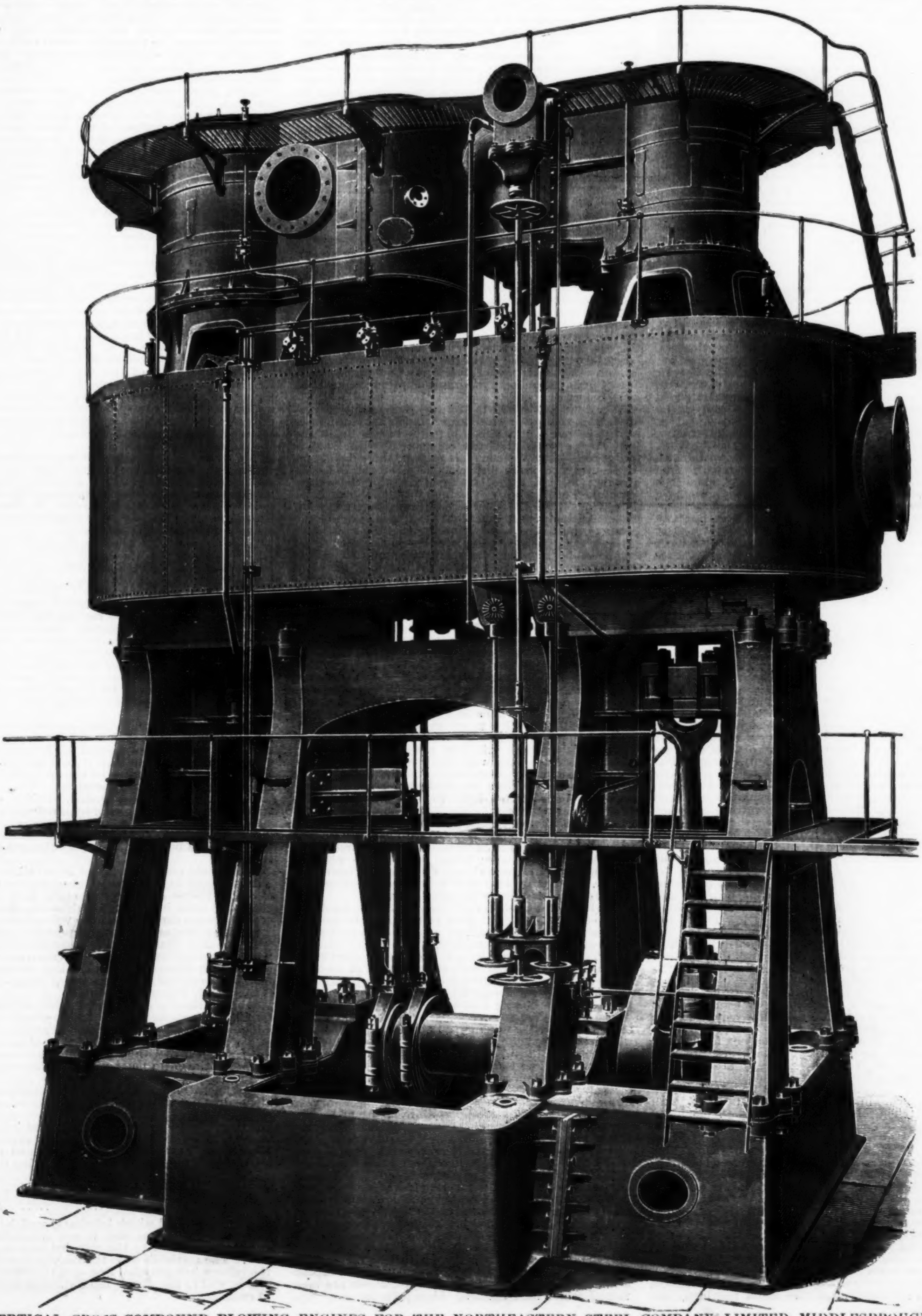

VERTICAL CROSS-COMPOUND BLOWING ENGINES FOR THE NORTHEASTERN STEEL COMPANY, LIMITED, MIDDLESBROUGH.

COMPOUND BLOWING ENGINES.

OUR engraving represents a pair of vertical cross-compound blowing engines made by Messrs. Sir Christopher Furness, Westgarth & Company, Limited, of Middlesbrough-on-Tees, for the Northeastern Steel Company, Limited, also of Middlesbrough. This fine pair of engines is designed to work at an air pressure of 15 pounds per square inch, the steam pressure being 70 pounds to the square inch at the engines and a vacuum of 10 pounds in the exhaust pipe near the low pressure cylinder when running in ordinary work at 50 revolutions per minute. The two air cylinders are 84 inches in diameter by 54 inches stroke; the steam cylinders, 48 inches and 84 inches in diameter by 54 inches stroke. The centers are 15 feet, and the total height from the floor line of engine house is 30 feet 9 inches to the top of the cylinder covers. All bearing brasses and bushes are of phosphor-bronze. Care has been taken to reduce the clearances to the lowest possible point. Both cylinders are double-ported. The bodies of the cylinders are 2 inches thick, steam ports and valve chests 1¼ inch thick. A false valve face of hard cast iron is fitted to the high pressure cylinder, secured by countersunk headed Muntz metal screws. A spring loaded escape valve, with brass adjusting screw and protecting domes, is fitted to each end of each cylinder, and a weighted safety valve is fitted to the receiver between cylinders. Drain cocks, indicator pipes, and cocks with the necessary gear, are also fitted to each cylinder. The cylinder covers are very strongly ribbed, and the bolts have nuts of extra depth. Starting screws and lifting eye bolts and a manhole to give access to each end of the low pressure steam cylinder are provided. The valve chests are separate castings with separate covers on the top. Sight holes are fitted for setting valves. The riveted steel exhaust pipe between the two cylinders is large enough to give the necessary receiver capacity.

The air cylinder castings are 2 inches thick in the body, and are recessed at each end, suitable flanges being cast upon the cylinders for carrying the air outlet valves, which consist of cast iron gratings and guards with leather flaps. The area through the inlet valves is one-fifth the area of air piston, and the area of air outlet valves two-thirds the area of the inlet valves. Special care has been taken in designing the air cylinders and their covers to reduce the clearance to a minimum, the limit aimed at being 3 per cent. At the same time care was taken that ample area should be left for free passage of air to and from the cylinders. Indicator cocks and pipes with the necessary gear are fitted to each cylinder. The bottom covers of the air cylinders are arranged to form the entablatures to rest on the main side frames, and support the air and steam cylinders. The top cover standards support the steam cylinders. These standards were designed as open as possible to give access to valves and stuffing boxes. The inlet air valves are fitted to these covers, and are so arranged that they can be withdrawn when necessary for examination and repair. One valve on each cover is of such a size that when it is removed, the opening is large enough to serve as a manhole.

The steam and air pistons are of cast iron, box section, well ribbed and strengthened. Separate cast iron junk rings are fitted to each piston with large bolts having brass nuts in the steam pistons. Mather & Platt's patent rings and spring are fitted to the high pressure piston, and a metallic ring with coach springs to the low pressure piston. The latter is so arranged that Mather & Platt's rings can be fitted if desired. Metallic rings with coach springs are used for the air pistons, which are so arranged that hemp or cotton packing or Mather & Platt's rings can be fitted if desired.

The slide valves are of the ordinary double ported description with "Meyer" expansion valves on the back of each main valve. The valves are secured to their rods by large washers and double brass nuts. There is a steam balance piston on the low pressure valve rod for carrying the weight of the valves. The main and expansion slide valves are worked by cast iron eccentrics, with large wearing surfaces, and are fitted with extra strong cast iron eccentric straps. The rods and gearing throughout are very strong, especially those for the low pressure cylinder valves. All working parts are fitted with adjustable phosphor-bronze brasses or bushes. The expansion valve gear is arranged for varying the cutoff from three-tenths to seven-tenths of the stroke. This gear can be worked externally, in the case of both high pressure and low pressure engines, from the starting platform near to the main steam stop valve wheel.

The piston rods are of iron 8½ inches in diameter. They are fitted to the pistons with cone bearings and strong nuts. The connecting rods are of forged iron, machined, and finished all over. The jaw at the top ends is fitted with double phosphor-bronze bushes, the bottom end bushes also being of phosphor-bronze. The bolts are of steel, not less than 4¾ inches in diameter. The connecting rods are 8 inches in diameter at the smallest end and 9 inches at the larger end, and 10 feet long between centers. The crossheads are iron forgings, the journals 7½ inches in diameter by 9 inches long. They have cast iron slide blocks with wearing surfaces 12 inches by 24 inches.

The bedplates, as will be seen, are of box form, being 4 feet deep from center of crankshaft, and are very strongly designed. The vertical webs are 1¾ inch thick, increased to 2 inches under the main bearings. The top and bottom flanges are 2 inches thick, increased to 3 inches in the way of main bearings, with mid-feathers. The jointing flanges have been machined and fitted metal to metal without chipping strips. The main bearings have phosphor-bronze bushes, 18 inches in diameter by 2 feet 9 inches long, and 2 inches thick at top and bottom; the bedplate having been machined to receive the bushes, the bottom halves being semicircular, so that they can be withdrawn for examination without lifting the shaft. The keeps are of forged iron, each fitted with four steel bolts 4 inches in diameter. The faces upon the bedplates for receiving the columns and their fittings have been planed and fitted metal to metal without chipping strips. Holes are cast through the bedplate in suitable position for twenty holding-down bolts.

The columns or the main frames are of box section, as shown in our illustration, the metal not being less than 2 inches thick. The flanges are very substantial, and are fitted with deep bosses for eight or ten bolts to each foot. Guide plates are made of hard cast iron, and fitted for the piston rod slides with suitable means of adjustment. Brackets are provided upon these frames to carry the platform, and a strong cast iron stay bracket is fitted between the two engines at the top of the columns to tie them together.

The crankshaft, which is of forged iron, is 18 inches in diameter at the main bearings, 20½ inches at eccentric seats, and 22½ inches diameter for the flywheel. Forged cranks are shrunk onto each end of the shaft and securely keyed. The cranks are of iron machined all over, and fitted with forged wrought iron crankpins 12 inches in diameter by 15 inches long, shrunk into the cranks and pinned. The flywheel is not shown in our illustration. It was designed to be 16 feet in diameter by 15 inches wide on face, and to weigh not less than 35 tons, including the balance weight. The wheel was to be made in halves, the joints planed and securely bolted, solid rolled steel rings being shrunk on the boss, one at each side. The wheel is to be staked on the shaft by light planed steel keys. A strong air casing is fitted between the two air cylinders, having an outlet branch about 4 feet 6 inches in diameter. There is a 12½-inch steam stop valve to the high pressure cylinder. Oil boxes are fitted so that the engines may run continuously, and there is a large brass oil box to each main bearing, with collecting trays underneath. There is also a small pump to be fitted and driven by the shaft itself for returning the oil from the collecting boxes' trays to the oil boxes, so that a constant stream of oil is passing round the bearings. The United States Company's patent metallic packing is fitted to the piston rod and valve rod stuffing boxes on the steam cylinders, and to the top piston rod stuffing boxes on the air cylinders. The makers' "Cleveland" metallic packing is used for the piston rod stuffing boxes on the bottom of the air cylinders.—Engineering.

THE COVERING POWER OF WHITE LEAD.

IN a former issue, the Farben Zeitung says: It has frequently been suggested to obviate the danger of lead poisoning by using less poisonous or non-poisonous pigments instead of the lead colors. Unfortunately these attempts have been unsuccessful so far. We neither have a pigment capable in every respect of taking the place of white lead, nor a medium to effect the quick drying of the varnishes in a different manner than by the admixture of litharge. Consequently the use of plumbiferous colors cannot be prohibited for the time being.

The questions arise: Is it really impossible to produce a substitute for white lead? and What constitutes the great value of white lead? Its merits lie in the covering power. It is true commercial white lead is not always equivalent in this respect, there being, on the contrary, a great disparity between the different products as regards the faculty of covering the underground. This is readily explained by the following: It is obvious that the micro-crystalline structure of a chemical compound must have an influence on the lesser or greater permeability to light of the substance. The covering power of a substance—in this case of the pigment—is, therefore, the faculty of absorbing the rays of the light falling upon it. It naturally increases with the thickness of the layer, so that eventually even a poor covering paint, applied in sufficient thickness, will become impervious to the rays of light, and becomes opaque, i. e., hides the lower ground from sight.

If different varieties of commercial white lead are compared under the microscope a difference between the various products will soon be perceptible, it being apparent as follows: According to the circumstances under which the small particles of the matter (the atoms) have aggregated into a chemical combination, the final products of the chemical reaction occurring in this manner vary. This is visible under the microscope, as follows: The micro-crystalline structure appears composed of infinitely small colored or transparent crystal-aggregates. The non-crystalline, amorphous substances, however, prove to be at this observation in such a high condition of fine division that even with very strong magnification they will allow only very little or no light to pass through; hence they appear opaque.

A body of inferior covering power, it is true, will also, as has been pointed out, possess the faculty of closing up the underground from view, but this requires a considerably thicker layer; hence much more pigment must be emploeyd, and the coating is made immensely dearer. Let us see how the white leads obtained by various methods behave as regards opacity.

The best white lead in every respect is that produced by the German process. The Dutch product may be equivalent to the German, as regards opaqueness, but as far as whiteness is concerned, it is inferior to the latter. This is due to the fact that the product made with manure is tainted with slight traces of lead sulphide (occasioned by the forming hydrogen sulphide vapors) whose black color injures the pure white of the pure hydrocarbonate (the white lead). The product won by the French process, however, is more micro-crystalline and less opaque, but excels by its excellent whiteness. But how is it with white lead obtained by precipitation of lead solutions with soda (or ammonium carbonate)? The lead carbonate thus produced has a micro-crystalline structure and is of inferior value for painting purposes, owing to the consequently inferior covering power. It is, therefore, necessary to retain the laborious methods afore mentioned. The last named product could, of course, be manufactured much cheaper, but for the sake of the covering power one is compelled to use the dearer process.

The scope of this article, in order to treat the subject exhaustively, has to be somewhat widened. So far we have only considered the covering power of the powder in a dry state. In the prepared paint another factor is added, viz., the influence of the liquid used in preparing the paint upon the covering power. It is well known that the opacity of a substance in powder form and in a perfectly dry condition is considerably greater than in its mixture with a liquid and that it varies according to the liquid employed. In explanation the following well-known applications are mentioned, which have matured this experience.

When a jeweler desires to test a precious stone for its value, and especially for freedom from interior cracks, he employs a method which is founded on the above observations. Substances can be rendered transparent by immersion in liquids of equal refractive power. Thus the jeweler employs sassafras oil or similar ones to test the stones as regards their interior; by this method he recognizes the interior cracks and is thus enabled to judge the value of a gem.

That which the goldsmith applies daily, the painter has to carry out daily, consciously or unconsciously, on a large scale. A powder which is quite opaque when dry is very different in a moist state as regards covering power, according to the liquid used for grinding the color. If the liquid is such a one that it completely evaporates after the application of the paint, nothing is changed as regards opaqueness. As examples are the water colors; when a water color coating is put on, the underground is clearly visible through the same. But when the water has evaporated, after the drying of the color, the lower ground recedes, only the applied color being visible in the opacity, corresponding to its dry state; in other words, for a water color coating, the covering power of the applied dry color is equal to the covering power of the dry powder. The same thing applies, of course, to pigments, which are put on with alcohol or readily volatile essential oils. Here the respective liquid does not affect the covering power of the finished coating either.

Chalk, heavy spar, gypsum, and other white colors are known to afford excellent water color coatings; with oil, however, their covering power suffers greatly, only several applications of the paint leading to the desired end. The reason lies in the almost equal refractive power of the dry pigment to that of the oil used in grinding; the oil does not evaporate, but merely dries. The action of both the liquid and the pigment upon the luminous ray striking it is to be considered here.

Most suitable for oil paint will be the mixture of pigment and varnish whose indices possess the greatest difference in their power of refraction. This point is the "sine qua non" of all oil paint coatings, which, consciously or unconsciously, finds daily application.

Let us return to our white lead. White lead is, among all white pigments, that which, as a paint, possesses the greatest covering power, the difference of the indices of refraction of the two components, varnish on the one hand and lead hydrocarbonate on the other hand, being a rather large one. It is well known that the refractive power of all lead compounds is very great; we would only mention here the technically important application of this fact in the glass industry, viz., lead glass. Lead chromate is known to have the highest index of refraction of all substances examined so far, greater than the diamond. As a painter's color, therefore, chrome yellow is excellent, owing to its great covering capacity. Next follow lead carbonate and then lead sulphate.

The question, How can we obtain an opaque white equivalent in its action to white lead, may, therefore, be answered as follows: Find a substance which has, besides a pure white color, a factor nearly equal to the index of refraction of white lead. At the same time this substance must be readily obtainable in a pulverous (not micro-crystalline) state.

LUBRICANTS FOR GLASS STOP-COCKS.

By FRANCIS C. PHILLIPS.

THE success of modern chemical research work depends frequently upon the maintenance in position for considerable periods of complex forms of apparatus in which glass stop-cocks play an important part, and the failure or breakage of a stop-cock often proves to be the cause of serious loss of time or material. The efficiency of a stop-cock is, however, quite as much dependent upon the lubricant used for its protection as upon the skillful workmanship of the glass-blower in its manufacture.

It has been the common practice to employ an animal fat or a mixture of such fats for lubricating the stop-cock plugs of apparatus of all kinds and for work of every description, although it is a fact of experience that such lubricants are often a source of inconvenience and even danger to the apparatus.

A stop cock lubricant should, besides overcoming friction, satisfy the following requirements:

1. It should adhere to the glass, and should not be loosened by water.
2. It should be little affected by changes of temperature.
3. It should not be saponified by alkali.
4. It should be sufficiently transparent or translucent to render visible any clogging of the hole in the stop-cock plug while in use, and to show whether air spaces occur between the plug and the walls of the stop-cock.

Ordinary fats are so easily saponified and adhere so feebly to glass that they are seldom suited to the purpose. Pure rubber heated to a temperature sufficient to render it permanently viscid has advantages over fats, but its adhesiveness is lessened by moisture, and it is completely removed by alkali.

Schmitz (Ztschr. Anal. Chem., 1884, 516) recommends for glass stop-cocks the use of gutta percha dissolved in a high-boiling mineral oil. This mixture, although not saponifiable, does not adhere well to glass. If thinned down sufficiently with oil, its lubricating qualities suffer, while the gutta percha tends to become granular if the mixture is made thicker.

Vaseline, which is sometimes recommended for use alone, does not adhere to the glass, and does not overcome friction.

With a view to producing a lubricant better adapted to use on glass stop-cocks, a series of experiments has been tried. Various mixtures of softened rubber with other substances were tested. On mixing together

Pure rubber	70	parts.
Spermaceti	25	"
Vaseline	5	"

a mass is obtained which lubricates well, is translucent, adheres to the glass, and is not saponifiable. The vaseline was added to the mixture to increase its softness. The materials were thoroughly mixed while hot, the rubber being melted first and the others stirred in.

It is well to use a little more vaseline in winter than in summer.

Another preparation, which gave still better results, was made by mixing—

Pure rubber.... .... 70 parts.
Yellow unbleached beeswax.. . ..... 30 "

The rubber should be pure and fresh. Old rubber, or scraps of worn out tubing, whether black or red, will not answer as well, and may cause the mixture to become more or less granular and opaque when used in the stop-cocks. The rubber is best heated in a covered vessel until thoroughly melted, and then the wax should be added. The hot mixture is well stirred. No vaseline is needed. This lubricant is very serviceable, protects stop-cocks from sticking, even when used for concentrated solutions of caustic alkalies, and is quite translucent in thin layers. Care should be used not to scorch the mixture in its preparation. Strong alkalies tend in time to loosen and emulsify all lubricants, and the stop-cocks should occasionally be cleaned and recoated.

It has been attempted to increase the adhesiveness of such lubricants by the addition of small quantities of balsam of fir and other strongly adhesive substances, but difficulty was found from the tendency to cause sticking of the stop-cock plug. The rubber mixtures should not be exposed to the air longer than is necessary during the heating, and they should be preserved in closed bottles.

Various mixtures of gutta percha with wax and with oils were tried, but the gutta percha tends to cause granulation and diminishes adhesiveness. The mixtures above recommended may be readily removed from parts of glass apparatus which are difficult of access for cleaning, by the use of a little concentrated nitric acid, which quickly attacks and loosens it so that it may be washed out by water.

No lubricant is fit for use unless it renders the stop-cock nearly or quite translucent, so as to show whether or not the plug is coated over its entire length.

A thick rubber and wax mixture is especially suited for well ground glass stop-cocks upon gas vessels which are to be exhausted, and which have, therefore, to sustain the full pressure of the atmosphere. Such mixtures have been in use for stop-cocks of ordinary burettes in volumetric work during about two years, and have given satisfactory results in every way.—Journal of the American Chemical Society, xx., No. 9.

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UNIVERSITY OF PENNSYLVANIA LECTURE COURSE.

PECULIAR LAWS AND CUSTOMS IN THE AMERICAN COLONIES.*

THE PENAL LAWS AND PUNISHMENTS.

JUST as the general legislation which we have considered was largely based on English precedent, so the criminal codes and punishments of the colonies were not the product of their own minds but, with few exceptions, were patterned after the statutes, the orders and customs of the older governments of Europe, especially those of England. In examining these laws and punishments I ask you to remember that the colonists were Englishmen or other Europeans of the seventeenth and eighteenth centuries, and not social scientists and law reformers of the closing years of the nineteenth century; and we should judge them by the seventeenth, and not by the nineteenth and twentieth century standards. They were, in the main, unconscious of the barbarity of the English criminal code; and it is small wonder that some of its barbarities were reproduced on this side of the water.

The Massachusetts authorities seem to have been perfectly sincere when, in spite of their declaration in their "Body of Liberties" that "We allow no bodilie punishments amongst us that are inhuman, barbarous, or cruell," they still continued, in common with the universal practice elsewhere, to nail offenders' ears to the pillory, crop and slit the same members, and brand criminals with red hot irons.

It is commonly supposed, owing to the popular odium attached to "The Connecticut Blue Laws," that colonial New England was distinguished in its age for the severity of its laws. Such, however, is not strictly the case. While it must be freely admitted that the laws not only of Connecticut, Massachusetts, and many of the other colonies were certainly blue enough, they were not as severe as the laws of England at the same time, and in several particulars were far in advance of the age. By the first codes of Massachusetts and Connecticut, twelve offenses incurred the penalty of death—in the New Haven, fifteen—all sustained by citation from the Mosaic code of the Old Testament; while in England, at the same time, thirty-one offenses were so punished. Thus it appears that the Puritans in New England had made a reduction of from over one-half to nearly two-thirds in the number of capital offenses. The capital crimes in New York, by the Duke of York's laws, adopted in 1664, were fixed at eleven. Even Pennsylvania, which started out with the remarkably small number of one capital offense, had by 1718 so increased the same that twelve crimes were punishable by death. Included within this list were robbery, burglary, manslaughter by stabbing, witchcraft, and arson, and counterfeiting was later added. Every other felony except larceny was considered a capital offense upon a second conviction. All the above mentioned crimes were still capital at the revolution. Fortunately, however, the enforcement of law was tempered with mercy. That real progress had been made in the colonies is apparent when we recall that in England the number of capital crimes was gradually increased until the year 1819, when they had reached the almost incredible number of 223, when at last a radical reform was inaugurated.

Among the means employed for the infliction of punishment for crimes and misdemeanors in past centuries were several curious, grotesque, and barbarous methods. We are first impressed by the fact that publicity played a most important part in connection with all punishment. Several of the modes of punishment were designed rather for the infliction of disgrace than pain; such as the degrading and helpless exposure in the stocks or pillory; the standing in a winding sheet before the congregation on Sunday, or under the gallows with a rope around the neck, or sitting in a cage; or the wearing of symbolical letters, or telltale placards; so that the fear of ridicule and insult, with exposure before neighbors, was used to the fullest extent as a deterrent of crime. Even those other punishments which caused pain to the unfortunate culprit, such as ducking, whipping, branding, and maiming, were almost invariably effected in public.

One of the first of these instruments for public exposure to be introduced into the colonies was the bilboes. It consisted of a long, heavy bar of iron, affixed to which were two sliding shackles or anklets, and had at first been in use on board ship. In the absence of jails it was found convenient for the early colonists to thus restrain the freedom of vicious and lawless persons, as well as punish by public exposure misdemeanors of lesser culprits. The bilboes being made of iron (which, at that time, had to be imported from England) soon gave place to the wooden stocks, which shortly became an article of domestic manufacture and were in use for the punishment of petty offenses of male offenders. There are instances on record where women were placed in the stocks, but these are very few. That the stocks are a very old engine of punishment—in use at least 2,500 years ago—is evident from the reference to them in Jeremiah (xx: 2), where we read: "Pashur smote Jeremiah, the prophet, and put him in the stocks that were in the high gate of Benjamin, which was by the house of God." The colonists not only imitated the Jews in the use of the stocks, but also in their location; as they, too, were accustomed to set them up near the meeting house or other public place. This form of punishment was usually confined to the lower class for such offenses as drunkenness, uncivil carriage, reviling the magistrates, remaining away from the meeting, sleeping, jesting, or other unseemly behavior in meeting; the more aristocratic punishment of the pillory in the earlier years being reserved for gentlemen. The pillory was in constant use in England, from as far back as the twelfth century; and, like the stocks, whipping post, and ducking stool, was known in all the colonies. Each county or town was obliged to maintain these "engines of punishment." Thus, by a law of Virginia in 1662, in every county the court was required to set up a pillory, a pair of stocks, a whipping post near the courthouse, and a ducking stool, in such place as they think convenient, on pain of the court forfeiting 5,000 pounds of tobacco. The unfortunate culprit who was exhibited to the public in the pillory or stocks was sometimes subjected to all manner of indignities and abuse by the populace, who might take a fancy to assail him with decayed vegetables, stale eggs, or with such heavy missiles that death sometimes resulted from these attacks. The tendency seems to have been to reserve the pillory for the punishment of greater crimes. It appears to have remained in general use much longer than the stocks; for we find reference to it in New England in the early years of the present century; and it was not unknown in England as late as 1830; but the punishment was finally abolished by Parliament in 1837. It still is regularly used in the neighboring State of Delaware as a punishment for such crimes as theft and burglary.

The whipping post was also common to all the colonies; and whippings were meted out for a large variety of offenses. The colonial laws and court records of Pennsylvania seem to resound with the swish of the lash; and no picture of Philadelphia in the eighteenth century is complete without a whipping post and a well filled pillory. Thus, by the law of 1721, any person guilty of petit larceny (that is, taking anything under the value of five shillings) might be whipped upon the bare back not exceeding fifteen lashes, as well as making restitution and paying all charges. A law of 1772 was directed against mischievous persons who, in those days, as well as the present, had a weakness for souvenirs, or delighted to play practical jokes. Any one convicted of breaking or taking off the brass knockers affixed to doors, or carrying away or injuring any sign, was liable to a heavy fine or a public whipping, twenty-one lashes for the removing of knockers, fifteen for the appropriating of signs.

For heinous crimes the law, even of the Quaker colony, was very severe; two or more different kinds of punishment might be inflicted. Counterfeiters were stringently dealt with in all the colonies. By act of 1723 in this colony, the guilty party was "to be set upon the pillory in some open, public place; there have both his or her ears cut off and be publicly whipped with thirty-nine lashes well laid on," and in addition to a penalty of one hundred pounds, pay the party aggrieved double the value of damage sustained and the costs of prosecution, in default of which he was to be sold for any term not exceeding seven years. Even this law was not sufficiently stringent and gave place to an act, sixteen years later, making counterfeiting a capital offense, without benefit of clergy. Likewise, a person convicted of breaking into a public building was, by act of 1772, condemned to stand in the pillory one hour; have his ears cut off and nailed to the pillory and be publicly whipped with thirty-nine lashes and committed to the workhouse for twelve months. This act was in force nearly twenty years. Public whippings lingered long after the kindred punishment had disappeared. A case of public whipping in this city, outside the walls of the old Walnut Street Prison, is on record as late as 1817. Another occurred in New Haven, on the green front of Yale College, five years later. It was maintained in all the slave holding States until the abolition of slavery; and, as is generally known, the whipping post, as well as the stocks, still holds its own in Delaware, where its use is stoutly defended.

Branding and wearing of appropriate letters (a temporary and milder form of the same punishment) were made use of for a considerable class of crimes. As is well known, the motive of Hawthorne's classic story of the "Scarlet Letter" was based upon the New England practice. The Hester Prynnes of Plymouth were obliged to wear the significant letters of "AD" on their outer garments, on the arm and back, on pain of being whipped as often as found without them. A similar punishment was sometimes visited upon drunkards. Thus, in 1634 Bobert Coles, for drunkenness, was disfranchized by a Boston court, and ordered "to weare aboute his necke, and soe to hange upon the outer garment, a 'D,' made of redd cloath sett upon white; ta contynue this for a yeare and not to leave it off att any tyme when he comes among company under penalty of forty shillings for the first offense," and increasing fines for subsequent offenses. But this practice was not confined to New England, as a few examples from Pennsylvania will show. In this province, by an act of 1700, at the discretion of the judge, persons convicted of theft or robbery might be condemned "to be whipped and to wear a Roman 'T' for six months upon the outer garment, in open view, upon the outer part of the left arm, betwixt elbow and shoulder, at all times between sunrise and sunset. The 'T' to be not less than four inches in length each way and an inch in breadth, of different color from his or her outer garments—either red blue or yellow, as the justice shall direct."

For the first time found without the same the culprit was to be whipped, not exceeding twenty-one lashes; but for the second lapse, besides thirty-nine lashes, the 'T' was to be branded on the forehead, or banishment from the colony should follow. Even paupers were thus ignominiously ticketed in several of the colonies. A law of this province, of 1718, provides that "every person who shall receive any relief of any county, city, or place," and also his wife and children (if living in the same house), "shall wear upon the shoulder of the right sleeve of the upper garment, in an open and visible manner, a large Roman 'P,' together with the first letter of the place to which he or she belongs, cut either in red or blue cloth," on pain of losing their allowance or being whipped and confined in the house of correction.

Both in the North and in the South branding was a common form of punishment. Thus, burglary was punished by branding with the capital 'B,' usually in the hand; but if the crime was committed on Sunday, the branding should be on the forehead. For blasphemy, by a law of Delaware, about the middle of the eighteenth century, a three-fold punishment was visited upon the culprit; for in addition to the whipping and the pillory, the letter 'B' was branded on the forehead.

An important statute of Pennsylvania, of 1718, directs our attention to the means by which capital punishment was frequently commuted for a milder form. This act declares that "any person convicted of any felony as is hereby made capital for which he ought, by the law of Great Britain, to have the benefit of his clergy, and shall pray to have the benefit of this act, shall not be required to read, but without reading shall be allowed, taken and reputed to be, and punished as a clerk convict," and "branded, if for murder, with an 'M' on the brawn of the left thumb; and if for any other felony, with a 'T' in the same place as if he had read as a clerk. In addition such person shall be imprisoned for six months to two years." This law applied also to women. "Benefit of clergy" was originally an ecclesiastical privilege extended to the clergy in criminal cases, by which the ecclesiastics escaped with a lighter penalty than a secular criminal. When this privilege was inaugurated in England, in the middle ages, the test of reading was established in order to determine whether the criminal was an ecclesiastic or not; as only those who entered holy orders were supposed to be able to read. As education became more general, others besides the clergy availed themselves of this privilege, until we find the custom thus recognized by law and "benefit of clergy" became a constant plea. Hence, when it was the intention of the lawmakers that capital punishment should actually be inflicted, it was customary to add the words "without benefit of clergy." Thus arson, by the law of this province, in 1772, was made a "capital offense without benefit of clergy." All claim to this privilege was abolished in this State in 1794, as it had been a few years before in New York and Massachusetts; but it lingered in England until 1827.

The most grotesque, as well as the most ignominious of the whole category of punishments, was the ducking-stool. Saints as well as sinners have been exposed in the stocks and pillory, and martyrs have gone to the stake and the gallows; but the disgrace and humiliation of the ducking stool was reserved for that most disagreeable of persons—the common scold of the female gender; although instances are on record of quarrelsome couples being ducked back to back. Ducking was a familiar form of punishment in England, especially during the century of colonization. A humorous poem of Benjamin West, entitled the "Ducking-Stool," published in 1780, shows it was not unknown in his day. The poem is republished in Mrs. Earle's "Curious Punishments of Bygone Days," from which I have drawn several of these illustrations. It reads as follows:

"There stands, my friend, in yonder pool
An engine called the ducking-stool,
By legal power commanded down—
The joy and terror of the town.
If jarring females kindle strife,
Give language foul, or lug the coif,
If noisy dames should once begin
To drive the house with horrid din,
'Away!' you cry; 'you'll grace the stool;
We'll teach you how your tongue to rule.'
The fair offender fills the seat
In sullen pomp, profoundly great.
Down in the deep the stool descends,
But here at first we lose our ends.
She mounts again and rages more
Than ever vixen did before.
So, throwing water on the fire
Will make it but burn up the higher.
If so, my friend, pray let her take
A second turn into the lake,
And, rather than your patience lose,
Thrice and again repeat the dose.
No brawling wives, no furious wenches,
No fire so hot but water quenches."

The ducking-stool was especially popular in the southern colonies from the earliest period. I quote from a penal statute of Virginia, in 1662:

"Whereas, many babbling women slander and scandalize their neighbors, for which their poor husbands are often involved in chargeable and vexatious suits and costs in great damages, be it enacted that in actions of slander occasioned by the wife," "the woman shall be punished by ducking."

That such laws were not dead letters, but were really carried out, is attested not only by the court records but by such evidence as the following letter, written

* A lecture delivered March 10, 1899, by Herman V. Ames, Ph.D., Instructor in American Constitutional History, of the University of Pennsylvania, at the University College Hall. Revised by the author.

from Virginia, apparently to Governor Endicott, of Massachusetts, giving a graphic account of ducking that the writer had just seen administered "to one Betsy, wife of John Tucker who, by the violence of her tongue has made her house and neighborhood uncomfortable."

Then follows a description of this peculiar engine of punishment, and the account closes as follows:

"The machine was then moved to the edge of the pond; the rope was slackened by the officers, and the woman allowed to go down under the water for the space of half a minute. Betsy had a stout stomach, and would not yield until she had allowed herself to be ducked five several times. At length she cried piteously, 'Let me go.' 'Let me go.' 'By God's help, I'll sin no more.' Then they drew back the machine, untied the ropes and let her walk home in her wetted clothes, a hopefully penitent woman."

Even the colony of the mild Quakers was afflicted by these latter-day Xantippes. In 1708 a ducking-stool was ordered to be built by the act of Council of Philadelphia; but this order does not appear to have been carried out; for ten years later the grand jury petitioned that "a ducking-stool and a house of correction for the just punishment of scolding drunken women, as well as divers other profligate and unruly persons should not be any longer delayed, but with all possible speed provided for the detention and quieting of such disorderly persons." In course of time the ducking stool seems to have been set up; and as late as 1824 in this city a common scold was sentenced to be ducked, but escaped this penalty, as the punishment was "deemed obsolete, and contrary to the spirit of the times."

Military punishments were notoriously more severe than those ordinarily inflicted in civil life; but it is not my intention to harrow your feelings by recounting these barbarities. I wish, simply, to call your attention to one or two grotesque punishments peculiar to the army. Thus, riding the wooden horse, running the gauntlet, are some of the milder forms of punishment inflicted; but perhaps the most curious of them was the "barrel shirt" or "the drunkard's cloak," an old Dutch and English punishment of the seventeenth century. It was revived in the Northern army during the civil war.

Thus far I have omitted all reference to the large body of laws applying to special, but by no means inconsiderable classes of persons, namely, the laws regulating the conduct of negro slaves and indented white servants, and, in general, dealing with the relations between masters and servants. In all the colonies, especially those south of Mason and Dixon's line, there gradually developed a body of laws popularly known as the "Black Code." The whites, especially in those colonies where slaves were numerous, lived in constant fear of a negro insurrection; and so the laws regulating the conduct of the negro, whether free or slave, were very stringent. Even in Pennsylvania, where slaves were never very numerous, a law of 1706 forbade negroes, above the number of four, meeting together on Sundays or week days, except they were engaged in the lawful business of their masters, upon pain of being publicly whipped. Furthermore, down to the gradual Emancipation Act of 1780, negroes in Pennsylvania were by law subject to much severer punishment than were whites for committing the same offense.

But a more numerous and important class of laborers in Pennsylvania and the middle colonies generally than the negro slaves were white indented servants. These persons were usually recently arrived immigrants, who, in payment of their passage across the Atlantic, were bound out to service, usually for a term of from five to seven years. The presence of this class in the community naturally led to the enactment of laws regulating their conduct and status. Owing to the natural propensity of the indented laborer to try to escape from his obligation, laws were passed requiring the runaway servant to continue in the service of his master, after the expiration of his regular term of indenture, five days for every day he had been absent without permission; but, in spite of these laws, runaways were of frequent occurrence, as the advertisements in the newspapers of the day show.

With the advance of civilization came a more humane sentiment, which brought society to a realizing sense of the barbarity of the prevailing criminal code and swept away, not only the old forms, but also the old conceptions of punishment, so that to-day only here and there is any vestige of the old order of things to be found.

WIRELESS TELEGRAPHY.

Practically, wireless telegraphy is exceedingly simple. By means of two apparatus, a transmitter and a receiver, to which must be added a pole of a certain height, it is possible, by utilizing electric waves, to send dispatches to a relatively great distance without the necessity of employing a conducting wire between the transmitting and receiving apparatus.

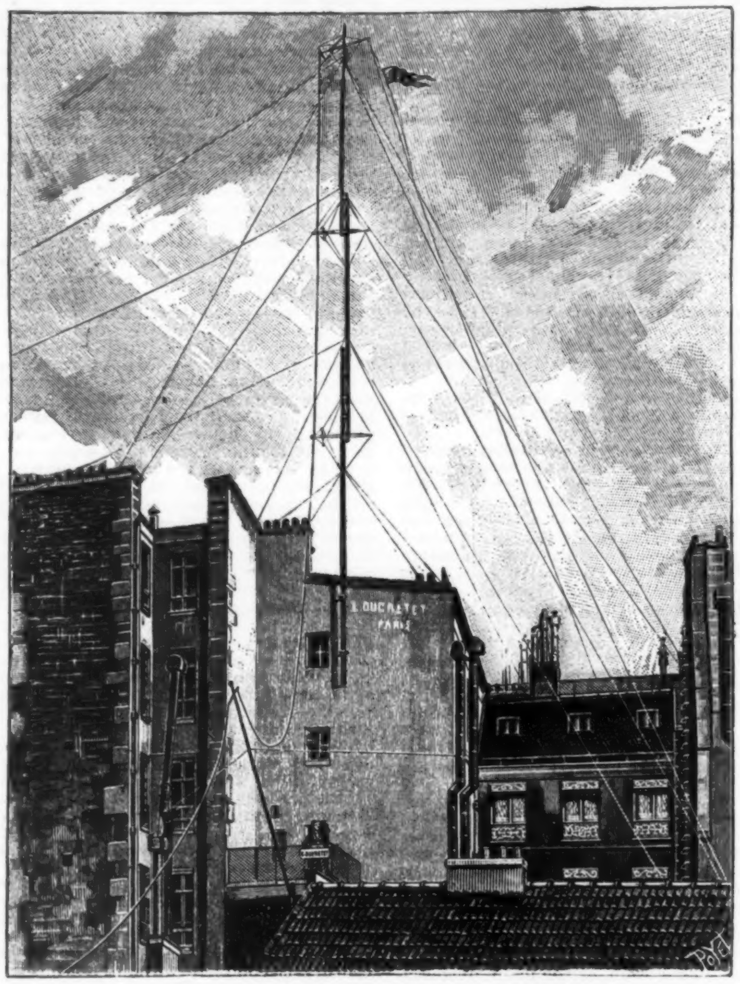
The very conclusive experiments which we were recently invited to witness by M. Ducretet, the learned manufacturer of physical apparatus, were performed while the receiver was placed in a room of which all the openings were closed. The electric waves, therefore, traversed the walls and were registered upon the receiver, which automatically unrolled a band of paper upon which was correctly inscribed the communication that was made to us.

Mr. Bichat, dean of the Faculty of Sciences of Nancy, not long ago delivered a very interesting lecture upon the subject of telegraphy without wires, of which the following is an abstract, given just as it was made and without the use of technical terms, the professor having proscribed these in order to make himself understood by his wordly-minded audience:

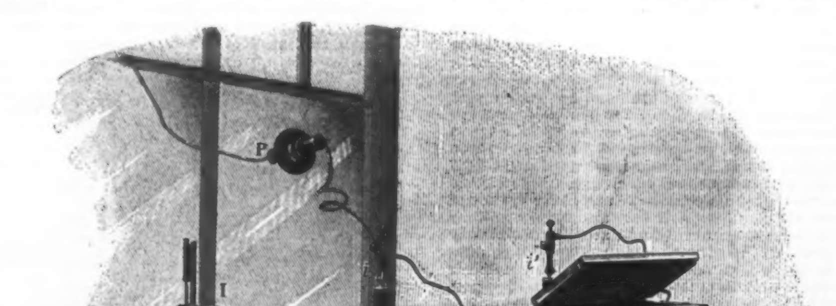
"We are so used to seeing the poles between which telegraphing is done connected by wires that it seems curious at first sight that it can be possible to suppress this intermedium, so the announcement of the discovery of wireless telegraphy caused some little astonishment, and, up to a certain point, excited public curiosity.

"And yet we have known for a long time how to transmit signals from one point to another, and, consequently, how to express our thoughts in conventional language without the necessity of establishing a wire between the two stations. This is what has been done, for example, in optical telegraphy, and this is what is done by the orator when speaking. Therefore, we make use of wireless telegraphy every day without being aware of it—just as M. Jourdain manufactured prose without knowing it. The only difference is that in optical telegraphy we use luminous vibrations, and, in acoustic telegraphy, sonorous ones, while in the new system of wireless telegraphy we place electric vibrations under contribution. The basis of the phenomenon is undulation or vibration.

"The concussion of a body causes the air to vibrate

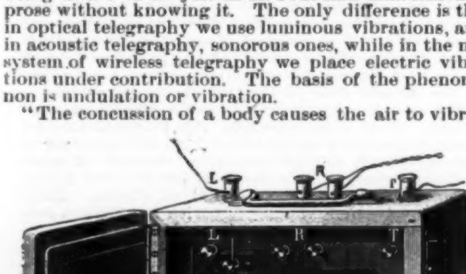


POLE RAISED ABOVE THE DUCRETET ESTABLISHMENT.



TRANSMITTING APPARATUS.

M. Manipulator. Bo. Induction coil. O. Spark oscillator. I. Interrupter with independent motor.



DUCRETET RECEIVER.

and produces therein an infinite number of undulations, which traverse and disturb space. If such vibrations meet with a receiving apparatus, they strike it and make it vibrate in its turn. In the same way as with luminous and sonorous vibrations, it is possible to obtain electric ones, that is to say, regularly rhythmed displacements of electricity, which are produced alternately in one direction and the other upon conductors. These electric vibrations, which travel at the rate of 180,000 miles a second, behave like sonorous or luminous ones. They traverse walls, wood, etc., but cannot pass through metals.

"In order to produce them very rapidly, M. Hertz employs exciters, and, in order to receive them, has devised a resonator receiver. M. Blondlot, of the Faculty of Sciences of Nancy, has made some remarkable observations upon this process. The resonator employed by Hertz, however, is, relatively speaking, not very sensitive. The spark that shows the presence of the electric waves disappears as soon as the apparatus is placed at a few yards from the transmitter; and wireless telegraphy would never have become an accomplished fact had it not been for a discovery made by Prof. Branly, of France, in 1890. The following is in what this important discovery consists: In a tube of insulating material (glass, for example) are placed some filings of metal. Two wires, passing through corks that close the tube, enter the filings. The tube is arranged upon a circuit comprising a battery and a galvanometer. Under such circumstances the filings conduct very poorly and the galvanometer needle undergoes but a slight deflection. If, in the vicinity of a tube, or even at a great distance from it, an oscillating spark be produced, the filings will immediately become conductive and the galvanometer needle will be greatly deflected.

"The electric undulations that are propagated through the air meet with the tube of filings, which performs the role of a resonator, and between the particles of filings there occur microscopic sparks, of which it has been possible to demonstrate the existence. Such sparks are conductive. They destroy the stratum of oxide that exists upon the parts in presence of the granules of filings, and, perhaps, even solder them together to some extent, and thus establish a more conductive chain. If, then, the tube happens to be struck, the conductive chain will be destroyed, the filings will arrange themselves in any sort of way, and the tube will again become a poor conductor.

"The tube of filings is an extremely sensitive revealer of the existence of electric oscillations in any given place. Prof. Branly has given this instrument the somewhat complicated name of 'radio-conductor;' but in foreign countries it is more commonly called a 'coherer.'

"We are now in a position to describe the various parts of an apparatus for telegraphing without wires and make the operation thereof understood.

"The idea of producing electric oscillations by means of a Hertz oscillator and of receiving them at a great distance by means of the Branly tube was successfully carried out by M. Popoff, a Russian scientist, in 1895, and afterward by M. Marconi, an Italian, in 1896.

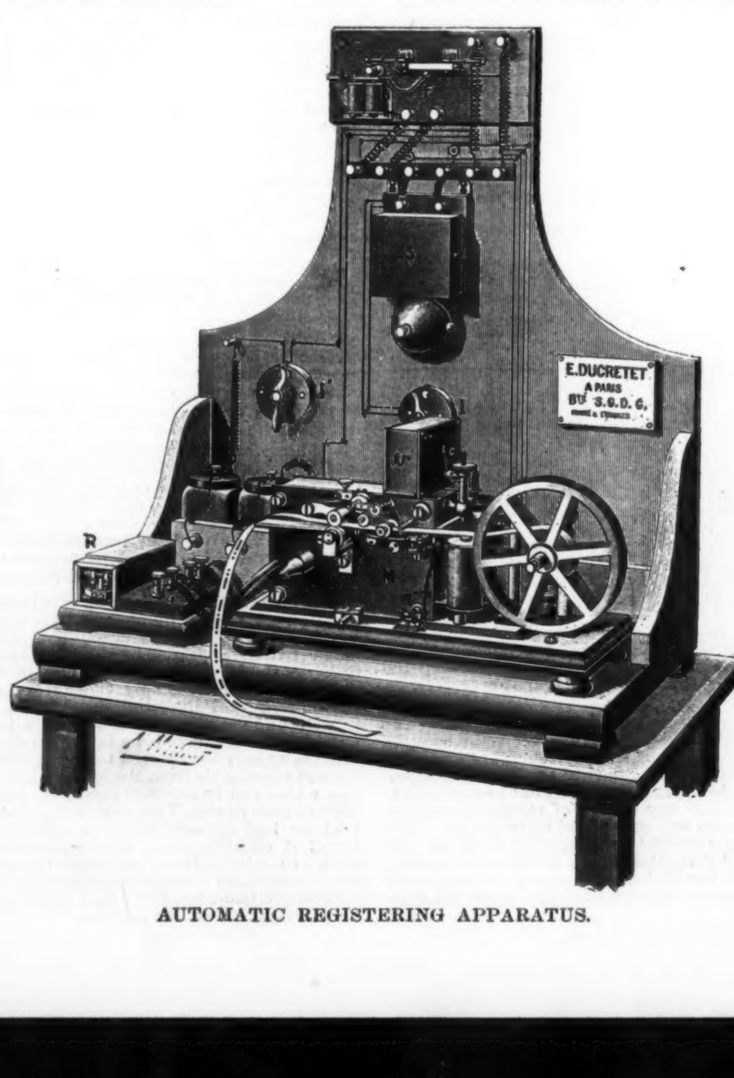
"In the meanwhile many French and foreign scientists have used the Branly tube for revealing the presence of electric undulations; and among these may be mentioned Prof. Lodge in England and MM. Le Royer and Van Berchem at Geneva. M. Ducretet, the well known manufacturer of physical apparatus, utilizing all such labors, has been led to introduce numerous improvements into the producing apparatus as well as into the receiving one, and has finally succeeded in constructing a model which operates with all the precision, sensitiveness and certainty desirable. The material comprises a transmitter and a receiver, absolutely as in ordinary telegraphy.

"The transmitter is a sort of radiator, that is to say, an apparatus for radiating the waves. It comprises (1) a hand manipulator through which are sent dashes and dots, as with the Morse manipulator; (2) an interrupter that, so to speak, divides the electric current into small currents; (3) an induction coil; and (4) an oscillator composed of metallic spheres placed in a liquid and between which the motions of the manipulator cause sparks to appear. From here the electric waves are sent into and through space. Where do they go, and where do they end? At the automatic receiver, which bears a strong resemblance to an ordinary Morse telegraph apparatus, from which it essentially differs, however, in that, thanks to the arrangement adopted by M. Ducretet, there is no necessity of calling in the services of a telegrapher. The sender of the message himself, as soon as the mysterious waves reach him, unwinds his paper, inscribes the signal upon the band, and immediately stops when the correspondent, with whom he is connected by nothing material, ceases to converse with him. Such automatism is certainly one of the most curious peculiarities of this system of telegraphy, which is so extraordinary, moreover, that no one at first would have dared to think it possible.

"When the site of the telegraphic station is surrounded by obstacles or rising ground, it is well to receive the waves through some overhead arrangement. M. Ducretet employs for this purpose a high pole, like the mast of a ship, which is either fastened to the side of a house or planted in the ground, according to the kind of communications that are to be had. This pole supports one of the extremities of an insulated conductor which floats in the air, while the other extremity communicates with the receiving apparatus of the telegraphic station. The latter is capable of either receiving or emitting waves, since it is provided with apparatus for both purposes."

With his apparatus, M. Ducretet has been able easily to send messages to the distance of two and a half miles comprised between the Pantheon and the Eiffel Tower, despite the numerous high buildings that stand between these two structures; and the signals received, even during a rain or the prevalence of a thick fog, have always been extremely well defined.

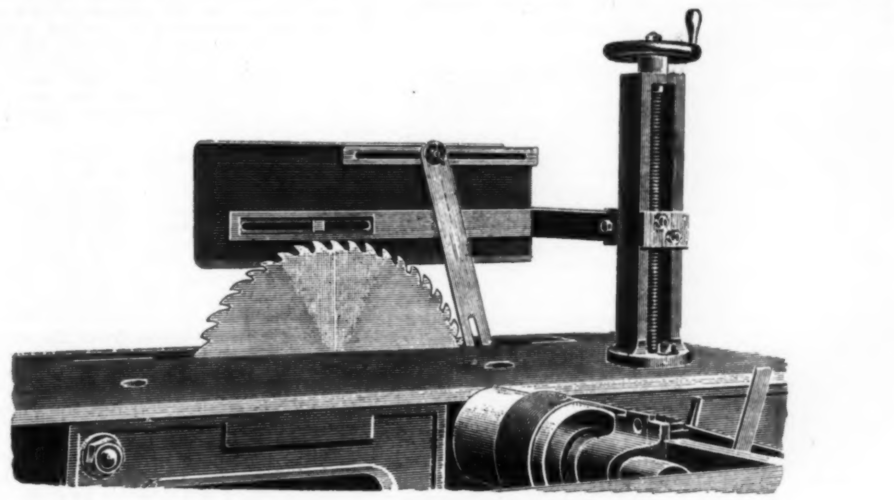
By increasing the power of the transmitting coil, there is no doubt that it will be possible to attain much greater distances.—Leon de Montarlot in Le Monde Illustré.



AUTOMATIC REGISTERING APPARATUS.

SCOTT'S CIRCULAR SAW GUARD.

WE illustrate on this page a guard for circular saws now being introduced by Messrs. Walker & Brothers, of 44 Constitution Street, Leith. The guard, as will be seen, consists of a metal plate, which can be carried on an arm, the height being adjustable by means of a screw as shown. Its position can further be adjusted longitudinally, since the bolt by which it is clamped to the arm carrying it passes through a slot. To protect the back of the saw a thin strip of steel is bolted to the main portion of the guard, and passes down behind the saw as shown, and is secured by a steady bolt below. This back guard is thin enough to readily enter the saw cut. When desired the guard is made to swing round out of the way, so as to enable the saw to be sharpened in place.—Engineering.


SCOTT'S CIRCULAR SAW GUARD.

RAILWAYS IN CUBA.

SOME interesting information concerning railroad travel in Cuba appears in a railroad guide recently published. The guide states that the railway managers in Cuba are intelligent and courteous, and that the way in which business is conducted compares favorably with that carried on in the United States. The roads are fenced in with cactus hedges and stone walls and the roads are laid with 50 or 60 pound rails. The rate of first-class passenger fare is about 5 cents a mile or 8 cents of the silver of the country. Baggage is transported on the European system, and an ordinary trunk costs at the rate of about a cent a mile. First, second, and third class cars are provided on nearly every train, though occasionally the classes are divided by partitions, so that the same car can be utilized by two classes of passengers. On one railway at least a buffet is conducted in the baggage car, and the articles to eat and drink are served in the passenger coaches. The caterers have evidently taken a leaf out of the American station restaurant keepers' notebook, for the charges are most excessive, sandwiches costing 20 cents, iced milk 40 cents, and other things in proportion. Capt. Hand, of Gen. James H. Wilson's staff, has made an interesting report on Cuban railroads, in which he states that the roadbeds are usually well built and fairly kept; they are of good width and well drained, and the main lines of more important branches are laid with steel rails, as already noted. Cross ties are mostly of the hard woods of the country, and are spaced at the rate of 2,000 to 2,640 to the mile. The bridges and culverts are of stone or of cement. All the bridges noted were of short span, with either iron girders or wooden stringers for superstructures. The station buildings and freight warehouses are mostly of concrete, with tiled roofs; the sidings are nearly all in bad condition, worn rails being utilized for the purpose, and the cross ties are rotten. The water stations usually consist of small iron tanks supported on concrete pillars and supplied from wells by steam, horse, or hand power. Y's are used for turning trains and are found every few miles along the line. There are about 1,100 miles of road in operation and 900 miles of this connects with Havana. The railroad employes are well paid, conductors receiving $60 to $100 a month; engineers, $120 a month; brakemen, $25 to $30 a month, and trackmen 50 cents a day, all payable in Spanish gold.

In a recent issue The British Iron and Coal Trades Review thus comments on the sale of American-made nails in england: "Figures published from time to time make it clear that the United States threatens Europe with serious competition in the nail trade, despite the fact that it is a highly finished product, as iron works' products go, and involves the employment of a large amount of skilled labor. At the average wholesale price of $1.08 per keg of 100 pounds, the United States appears to be prepared to sell cut nails at works for about $23, or about £4 15s., per ton, little more than the British price for steel nails. This, moreover, is not the price for export purposes alone, but the average American price for all purposes for a whole year. We have never heard of any price approaching this figure being quoted in Europe. British nail manufacturers would be likely to find it worth their while to ascertain how it is done, compatibly with the payment of the higher range of wages common to all American industries."

ENGINEERING NOTES.

The Twenty-sixth Middlesex (Cyclists' Corps), of England, are to experiment with a new gun carriage at the forthcoming volunteer maneuvers at Aldershot. It is said to be an electric motor tricycle with a service pattern Maxim gun affixed. Quick movement being essential, the gun can be instantly unlimbered and pulled or carried into position, the weight of the gun and carriage being only some 140 pounds.

The new station of the Lyons Railway in Paris is being built under a temporary wooden structure completely covering the proposed station, and protecting the workmen from snow, rain, and cold. Glass admits light in the daytime and at night electric light is used; the building is also heated. Continuous work is thus made possible, says The Engineer. This is not an unusual practice in Paris, as a similar protection was used in constructing the New York Insurance and other large buildings in that city.

The mechanical engineering department of the University of Illinois has just received and is now erecting in its laboratory a 10 horse power Otto gas and gasoline engine. This motor can be arranged to run either by gas from the city mains or by gasoline from storage tank. It is one of the most recent types of engines of this description and has a regulation sufficiently close so that it may be used for operating electric generators for lighting or power purposes. It will be used for experimental work and testing purposes in the laboratory.

An Alpine railway, to compete with the St. Gothard line for travel between Germany and Italy, is being discussed, says The Engineering News. This is the Bintschgau Railway, connecting Landeck and Meran, which may be built by Austria. The longest tunnel, that between Trafoi and the Zebru Valley, would be but 4·65 miles long, as compared with the 9 miles of the St. Gothard tunnel. This line would entirely avoid Switzerland. The route from Munich would pass by Fern, Landeck, Reschen, Trafoi, Bormio, and Lake of Como to Milan and Genoa.

Several prominent citizens of Chicago have presented to the Michael Reese Hospital, of that city, an electric ambulance, says The Electrical World. The vehicle, which was constructed by the Fischer Equipment Company, of Chicago, weighs 1,600 pounds, and it can attain a maximum speed of 16 miles an hour. The body of the vehicle is put on a separate set of springs, which reduces the jar and jolting to a minimum. This is said to be the first automobile ambulance ever constructed, and as electric vehicles offer peculiar advantages for this class of service, no doubt ambulances of this kind will become extensively used.

The New York, New Haven & Hartford Railway has adopted yellow for "caution" in signal indication. The home signals show a red light for "stop" and a green light for "clear," and the distant signals show a yellow light for "caution" and a green light for "clear." The arms of the distant signals are painted yellow, with a black stripe. Formerly white was the color for "clear" and green the color for "caution." The reasons for the change are traceable to an accident at Whittenton Junction, Mass., last fall, in which an engineer mistook a white light displayed on a crossing gate for the safety indication of a signal, subsequent investigation having shown that the signal was displayed in the danger position but the light of the lantern had gone out. In the annual report of the Massachusetts railroad commissioners, recently published, it is recommended that the use of white for a safety signal be discontinued.

A recent issue of the Brazilian Bulletin contains an account of the Ypanema Iron Works in the State of Sao Paulo, Brazil, which date from 1590, in which year two Catalan forges were erected by Alfonzo Sardinha. Work was carried on regularly until 1629, when the enterprise was abandoned because of the death of the owner. In 1760 a new furnace was built with leathern bellows and a trip hammer. In a short time this experiment was abandoned and the place became a sugar mill. In 1801 a blast furnace, with hand machinery to furnish the blast, was erected. This gave no results. In 1811 the government took charge, and contracted with certain Swedes to erect stückhofen and make bar iron. Four of these furnaces were erected and put in operation in 1814, but the ore proved so refractory that the yield was only 1 ton of iron for 41 tons of charcoal. The Swedes were dismissed and blast furnaces erected with proper blast appliances, and the system now employed was gradually developed. Pig and bar iron are made at the works, but the quality of both is inferior, owing to the poor quality of the ore. The Brazilian government is offering the works and the mines for sale.

Compressed air is now so largely used in foundry operations, such as for hoists, cranes, chipping castings, and cleaning them by means of the sand blast, we are not surprised to learn that the same agency is now used for the blackening of moulds. The February number of The Foundry gives illustrations of the apparatus used for this purpose. Liquid blacking, as is well known, is usually applied to dry sand and loam moulds by a brush or swab, and requires to be done with some skill to prevent scaling. It has to be laid on repeatedly, while still moist, to form a coating thick enough, in the moulder's judgment, to make the sand part readily from the casting, and to leave a good, smooth surface; and the heavier the body of metal in contact with the mould, the thicker usually does the coating require to be. But by this air pressure apparatus the blacking is laid on the surface in much the same manner as paint is sprayed. With properly proportioned nozzles a heavy spray of blacking is thrown with considerable force, driving it into the pores of the sand, and into the recesses and corners that are almost inaccessible by the swab. Further, it can be applied with much greater uniformity—a thing every founder will appreciate who desires fine-looking castings. The skill to properly handle a swab is not here required. Driving the blacking into the pores is advantageous, not only preventing the metal from burning into the sand, but greatly facilitating the work of slicking afterward, as the blacking will not so readily curl and tear off after the slicker. It is said to be rather quicker than the swab, and, as the coating is sure to be more uniform, we believe there is some economy in the amount of blacking.

ELECTRICAL NOTES.

Dr. Friedlander, of Wiesbaden, recommends galvanism to relieve the pain and irritation and to reduce the swelling caused by the bites of insects. The negative electrode is placed over the sting.—Medical Record.

It may not be generally known that Prof. Pacinotti, the inventor of the toothed armature, is still living, and is by no means an old man. According to The London Electrician, he is professor of physics at Pisa, but is not devoting much attention to electrical subjects. His famous dynamo of 1864 was exhibited at the recent exhibition at Turin, and besides this there were shown disks and drum armatures which antedate those of Siemens.

The chief of the Electrical Bureau of Philadelphia, Pa., David Walker, in his annual report states that at the close of the year 1898 there were 7,014 electric lamps in that city maintained at public expense—an increase of twenty-eight over 1897. According to the returns made by the telegraph, electric light, telephone and street railway companies, there were in overhead service on the highways of the city, exclusive of those along railroad tracks, 54,795 poles and 10,100 miles of wire.

The number of towns in Germany with electric car lines is reported as 68, and in 35 more similar enterprises are projected or under construction. The total capacity of dynamos and accumulators driving the 68 lines is 38,451 kilowatts. The average kilowatts required for one kilometer of track (ranging from 9·6 to 50·2 kilowatts per kilometer) is found to be 20·7, while the average number of kilowatts required per car (ranging from 6·2 to 46 kilowatts per car, according to local conditions) is 14·2.—Electrotechnische Zeitschrift.

Consul Schumann writes from Mayence, Germany, February 28, 1899: The telephone service of this country is a public institution controlled and managed by the Department for Posts and Telegraphs. The rates are certainly very low, the charge for a local telephone being $38.55 per annum, including the rental of the instrument. The service, however, is lacking in enterprise. I applied on February 20 to have a telephone placed in my residence, and was told that the connection could not possibly be made before May or June, as they did not string wires in winter.

The possibility of electrical combination locks for cash drawers and similar receptacles does not seem to have been realized to its fullest extent. It requires but little ingenuity to arrange four or five push buttons in such a way that only one combination will close the circuit of an unlocking magnet and any other will ring an alarm. The alarm could be placed at any convenient point, and at other points could be placed cut-out switches, which, when manipulated, would render it impossible even for one who knew the combination to succeed in opening it. An exchange says a device of this kind might be developed and made marketable.

Dr. H. Lewis Jones, of St. Bartholomew's Hospital, is now working out, in conjunction with Messrs. Arnold & Sons, the details of an electrically heated operating table in which incandescent lamps supply the heat. The body of the table has the form of an air chamber of metal, which may be divided into separate sections for convenience. Six or eight 16 candle power lamps inclosed in this chamber will rapidly raise an operating table to the required temperature, and half that number will then maintain the temperature at a proper level when the rest have been switched off. Wherever electric light circuits exist, this mode of warming an operating table, says Dr. Jones, would present decided advantages.—The Electrician.

A plan is now said to be under consideration by the British government for the lighting of the Pyramids by electricity, and the installation of an electric power transmission plant of 25,000 horse power. The plan involves the erection of a power-generating plant at the Assouan Falls on the River Nile, and its transmission over a distance of 100 miles, through the cotton-growing districts, where, it is thought, the provision of cheap power from this source will permit the building of cotton factories. Part of the scheme contemplates the lighting, from this source, of the interior corridors of the Pyramids, and also the operation of pumping machinery for irrigating large areas of desert lands along the Nile. It is also stated that an American company is likely to receive the contract for this work.

In an article in a recent number of The Engineering Magazine on "Industrial Progress in China," by J. S. Fearon and E. P. Allen, these interesting statements are made: The telegraph is the only institution of modern science which has obtained any considerable foothold in China. Peking is connected by wire with Tientsin and with Manchurian points up to the Russian frontier, whence connection is continued by Russian Siberian lines to Europe. The capital is also connected with all the treaty ports and principal cities in China proper, and these again with each other. Canton has connection also through Yunnan with Burma. China learned the value of the telegraph in the war with France, and it has long since been admitted to have become indispensable. The telegraph, however, is under imperial control, and there is probably little opportunity for its extension as a private enterprise. Chinese writing being not alphabetic, but syllabic, and there being as many characters as there are words in use, the telegraphic messages are sent in a number cipher. For transcribing messages received, a double-ended type is used; on one end is the character, and on the other the corresponding number. When a message is received, it is set up by the numbers, and then printed from the reverse, or, character, end.

A new field of usefulness has been found for the electric motor vehicle. A woman having received a complicated fracture of a limb which was difficult of location, the physician decided to resort to the Roentgen rays. The patient not being in a fit condition to be removed, and there not being any source of electricity on the spot, an electric cab was summoned by telephone. The current from the battery in the cab was conducted to the apparatus by special wires, which successfully operated it, and enabled the physician by the usual observations to locate the fracture, and to set the limb quickly.

SELECTED FORMULÆ.

Flavors for Cigars.—For flavors, the following are those most generally employed:

Orris	4 drachms.
Vanilla	4 "
Tonka	4 "
Alcohol	8 fl. ounces.
Water	4 " "

Make a tincture.

Cascarilla	12 drachms.
Valerian	4 "
Alcohol	8 fl. ounces.
Water	4 " "

Make a tincture.

Cascarilla	4 drachms.
Orris	4 "
Elecampane	4 "
Alcohol	8 fl. ounces.
Water	4 " "

Make a tincture.

Tonka	4 drachms.
Orris	4 "
Valerian	4 "
Alcohol	8 fl. ounces.
Water	4 " "

Make a tincture.

Havana stems	1 troy ounce.
Orris	4 drachms.
Tonka	4 "
Alcohol	8 fl. ounces.
Water	4 " "

Make a tincture.

To use these tinctures, dilute them with a mixture of 1 part of water and 2 parts of alcohol, using 3 parts of the diluent to 2 parts of the tincture. The liquid is applied as a spray. One ounce of the tincture should suffice for five pounds of tobacco leaves.

Blue Prints.—Ferroprussiate, or blue printing paper, which is much used for architectural and mechanical drawings, has the unfortunate habit of not keeping well, but the following will keep much better than the ordinary commercial makes:

Gum arabic	2 grammes.
Ammonio-citrate of iron	3 "
Tartaric acid	2 "
Distilled water	20 c. c.

Dissolve the solids by agitation or trituration in a mortar, and then transfer to a bottle of 50 to 60 c. c. capacity, and add liq. ammoniæ 4 c. c., and shake well. Then add the following solution:

Potassium ferricyanide	2·5 grammes.
Distilled water	10 c. c.

and shake the mixture well and allow to stand for a quarter of an hour. This solution, which must be kept in the dark, should be applied to the paper with a soft broad brush by artificial light and then dried in the dark. It is exposed under a negative in the ordinary way till the half-tones show a dark violet color, and it is then placed face downward on water for about ten seconds and removed, and exposed to the air for a short time, thoroughly washed in water, and then immersed in a bath of

Eau de javelle	50 c. c.
Water	1000 "

till it turns a deep blue.—Pharmaceutical Era.

Aluminum in Brass.—The reason that founders experience trouble in putting aluminum in their brass is, according to The Aluminum World, due to their putting too large a quantity of the metal into it. Our contemporary states that a piece as big as a pea in a pot of brass containing about 100 pounds of metal will prove beneficial to the mixture. From the experience of founders it would seem as if aluminum were a benefit to brass and bronze. At any rate, those founders who do not get good results from aluminum for their brass are those who do not know how to use the metal. In any event, the quantity of aluminum put into the brass should be very minute, unless the brass founder thoroughly understands aluminum and its alloys, and the effect it has on other metals. The best way to introduce aluminum into the brass is in the form of aluminized zinc, the standard mixture for which is 10 per cent. aluminum and 90 per cent. of zinc.

Polishing Powder.—

1. Rottenstone	1	ounce.
Magnesium carbonate, heavy	4	"
Phosphate of lime or precipitated silica	1	pound.
2. Rouge	½	ounce.
Magnesium carbonate, heavy	8	"
Precipitated chalk	1	pound.

Triturate the rouge with 2 ounces of the chalk for five minutes and gradually add the rest of the powders. Sift three times.

3. Magnesium carbonate	2	ounces.
Rouge, in powder	2	"
White bole	10	"
Lead carbonate	12½	"
Prepared chalk	25	"

Mix thoroughly. This powder may be used with a little water, or made into a paste with oleic acid and used as a polishing "pomade."—Pharmaceutical Era.

Restoring the Illuminating Power of Incandescent Lamp Mantles.—A recent number of Neueste Erfindungen contains an interesting account of an observation, made by Herr Franck, by which the illuminating power of the Welsbach mantles may be restored. The method was described by the author at one of the meetings of the Polytechnischer Verein, in Berlin. As is well known, the mantles decline in illuminating power after they have been in use for some time. This luminosity may be restored to a certain degree by blowing out the mantle from the inside while they are burning, which can be accomplished with the aid of a small glass or paper tube. The president of the society stated that he had personally tested the method and had found it effective, and, in consequence, recommendable. In order to facilitate the carrying out of the process the German Incandescent Gaslight Company manufactures a tube, mounted in a rubber ball, which is very convenient for the purpose.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Notes from Salvador.—Under date of March 3, 1899, Consul Jenkins, of San Salvador, writes to a trade journal in New York, as follows:

The fall in the price of coffee and the speculative spirit that led to overstocking the market have brought about the present financial depression. The demand for any class of goods cannot be stated, as the depression is general in character. The best houses have agencies in the United States which buy and discount their own bills. From my observation, I do not believe that the giving of credits is the best method of promoting trade. The competition for business has been very keen, and European houses have succeeded in obtaining the lion's share; but the result has been that they are compelled to suspend. A thorough advertising and exhibition of goods will, in my opinion, accomplish far more than credit. It must not be understood that there is no future here for American trade. I believe that in time prosperous conditions will again prevail in Salvador.

Obstacles to American Bicycle Trade in France.—Under date of March 21, 1899, Consul Jackson, of La Rochelle, sends the following:

If American wheels were sold at prices approximating those for which they sell in the United States, they would be purchased in this part of France in large numbers. It seems to me a serious mistake on the part of our cycle makers to give the sole agency of their wares for all of France to any one house. The result of this is that the prices are maintained at a very high figure. Machines which have always been known in America as "low priced" sell for about the same price as the most expensive at home. From figures recently shown me, one can buy certain wheels in New York at retail, pay the duty and transport, and then have them cheaper than the local dealer can purchase them from the agent at Paris. Consequently, there is practically no competition in the market between American and French cheap wheels, and fewer American wheels are sold. The conditions which obtain here as to advertising, travel by railway, exhibition of goods, etc., are so different from those in the United States that it is an immense undertaking, if we demand high prices, to successfully introduce one particular "marque" to 39,000,000 people.

Street Railways in Mexico City.—Under date of March 30, 1899, Consul-General Barlow writes from Mexico city:

The company owning the street railways in this city is about to substitute electric power for the animal traction heretofore employed. There are about 300 miles of track in the district which includes the city. One short line of 1½ miles is called the "Baños" (or Baths) line. The rest belongs to the Compañia de Ferrocarriles del Distrito Federal.

Until recently, mules have constituted the traction power. They are small, hardy, well-fed animals, and travel rapidly. On the outskirts of the city their usual gait is a gallop. For communication with suburban towns, the company has some large sixteen-wheel cars. Arriving at the outskirts of Mexico city, these cars are coupled into trains of five or more cars, and are thence drawn at good speed by American dummy engines. Most of the cars of the company are constructed in the United States, though at the city workshops of the company they make all repairs and have built some cars. The steam suburban lines will probably be retained and used chiefly for freight. The management is American. Mr. H. P. Bradford is president. The conductors and drivers are Mexicans.

The franchises granted are about the same as in other cities. The capitalization is $10,000,000. The street car fares vary according to distance. In the city proper they are 5 and 6 cents. Some of the suburban fares are as high as 30 cents.

The electric power will be obtained from coal. There will be no connection with the electric light plants now in operation.

Australian Butter Trade.—Under date of Cape Town, February 25, 1899, Consul-General Stowe submits the following statistics relative to the butter trade of Australia and South Africa:

The largest consignment of butter in one vessel (700 tons) which ever left Australia recently sailed in the "Austral" for England. The "India" had also on board 438 tons, so that in one week Melbourne has earned the credit of sending out the largest shipment of fresh butter which ever left any port in the world. Including a small consignment for Cape Town, the shipment comprised 54,000 boxes of butter. As an experiment, 800 dozen eggs were included among the produce for this port. The value of the butter and some 20,000 rabbits on board for England was $676,443.50. I call attention to this for the reason that my efforts to induce the producers of the United States to ship butter has met with but little success, although, as mentioned in a recent report, butter has arrived in South Africa from the United States under Australian marks. The total import of butter into South Africa (with the exception of Portuguese territory) for 1898 was 5,782,017 pounds, against 5,901,455 pounds for 1897; showing a decrease.

The Markets of Manila.—Mr. Oscar S. Williams, the late United States consul from Manila, writes that, in response to numerous inquiries from United States manufacturers, he has had a representative firm of importers prepare a statement and furnish samples of the goods most in demand in the Philippines, and this detailed report occupies some six pages of "the advance sheets." Manila is a consumer of a large quantity of fancy cotton articles, and the low quality of white shirtings which were formerly imported from Spain might well undergo a change in favor of better material and less finish. There is naturally not much use for woolens, but there is a certain consumption of flannel wool and heavy wool, light woolens, trouserings, etc., some light black cloth and scarlet woolen blankets are readily sold. In woolen as well as in silk goods, black is the favorite color. There is a market for certain lines of light and heavy linen. Manila is a large consumer of kerosene, and the Russian article competes with the American. Well-known trademarks are worth a great deal in the Philippine trade. Articles of great importance are iron, steel, galvanized iron, etc. Bar iron commands a considerable sale, the commission house who furnished the report selling 137,500 pounds per month. Galvanized iron is of great importance. The unsatisfactory results of tiling when subjected to earthquakes have resulted in houses being very generally covered with galvanized iron. Trademarks should be painted on each sheet. Great care should be used in packing, as a considerable rebate has to be allowed for goods stained by sea water. Other articles of large consumption are tin plate, wire nails, wire rope, zinc sheathing, yellow metal, etc.

The exports have also been greater than the imports, and, therefore, the tendency of exchange was to rise continually, and money became scarcer and scarcer. In 1897 the Spanish government minted Philippine dollars in Spain. They contained about ten per cent. less silver than the Mexican dollars, and the public had to take them at their value. It is believed that these light dollars are still in the country. The half dollars or twenty cent pieces which the government minted never came to the full value of Mexican currency.

How to Develop Trade with China.—In reply to inquiries from a Chicago correspondent, Consul Wilcox writes from Hankau, January 28, 1899:

In my opinion, the time is ripe for the United States to develop trade with China. Other nations are sending travelers all over this empire to learn what are the productions and needs of the various provinces, and how best to secure their share of trade.

I think the establishment in four or five of the leading commercial cities of China of expositions in charge of experienced business men who know the ways and language of the country is the best plan yet offered. Thirty years ago there were a large number of such men, citizens of the United States, engaged in business in China, but to-day they are few. The English, Russians, Germans, Japanese, and French conduct their trade here to a great extent through men who possess the above requirements. There are now a large number of Americans visiting China, representing various trade organizations in the United States. These representatives visit the ministers and consuls and request them to get dates for interviews with the Tsungli Yamên at Pekin, the viceroys, and other high officials in the various provinces of the empire. Their plans are similar, they are all from the United States, and they request the Tsungli Yamên to instruct the viceroys to gather specimens, to be sent to the associations they represent. Of course, each commission informs the officials that his league is composed of the most prominent and wealthy commercial men of his country. The consequence is that the Chinese officials, by having so many associations brought to their notice, are confused.

They have not the time or inclination to assist all, and, while they will promise to do many things to help the enterprise, they give little or no attention to the matter. If all these associations in the United States that are working to the same end and wish to accomplish the same purpose would unite into one organization, they could and would accomplish wonderful results. Business is not done in the same manner in China as it was thirty years ago, when it was virtually in the hands of foreigners. During these years, the Chinese have become educated in the manner of conducting commercial enterprises, and to a great degree have wrested the trade from the foreigners and carry it on themselves.

Proposed Department of Commerce in Great Britain.—Under date of March 23, 1899, Consul Marshal Halstead of Birmingham, says:

Mr. Ritchie, the president of the Board of Trade, in his speech at the dinner in London of the Associated Chambers of Commerce on March 15, announced the purpose of establishing a commercial department in Great Britain. He said that in many ways governments were moving in commercial matters in which, not very long ago, they never attempted to move at all, and that in this year's government estimates there was a sum of money for the establishment, under the auspices of the Board of Trade, of a new government department, in which would be collected and focused all the information which now exists in the various departments, so that any commercial man may be able to go to the office and obtain intelligence in a business-like way.

"This department is to be conducted by a committee which will be drawn from the India Office, the Foreign Office, and the Colonial Office, and will have added to it certain commercial men. In addition to that, there will be another sum of £2,000 ($9,733) upon the Foreign Office estimate for obtaining, by means of specially appointed persons, special commercial intelligence abroad. We also intend to publish the Board of Trade Journal weekly instead of monthly."

Mr. Halstead also sends the following clipping from Industries and Iron in its edition of March 17:

"We are rejoiced to see that at last a reform, whose pressing necessity we have repeatedly urged in these columns, may be regarded as a fait accompli. We are now authoritatively informed that the preparation and publication of the consular reports will pass from the control of the Foreign Office to a specially created department of the Board of Trade. We have repeatedly suggested this and given our reasons in detail for the desirability of the change. The government has evidently the intention of copying to the fullest degree—and perhaps of improving on, if that be possible—the example set this country by the United States. Accepting this as the fact, there are one or two considerations connected with consular reports which we would desire to emphasize. They should be issued free to the chief organs of the general and technical press. We are, of course, far from suggesting that financial considerations have anything to do with the matter so far as the press is concerned. But it is quite evident that the matter comprised in the reports is of general importance, and it should therefore be given the widest publicity possible. Therefore, the trouble of sending and paying for the reports as they appear should be obviated. Their length and the frequency of their publication should be carefully apportioned in a relative degree to the interests involved. There is no doubt that a part of them should be telegraphic, and be published day by day. Lastly, the preparation of the reports should be placed in the hands of competent men of the highest commercial training and experience, and should be edited before publication by some one qualified to criticise them and capable of guiding and instructing their authors. We do not profess ourselves as exactly sanguine as to the entire accomplishment of the programme indicated by these premises; but if we get something even approximating to it, we shall have cause for gratitude."

The consul adds:

The best is not good enough for the United States, and in that sense the agitation at home for an improvement of our consular service is useful; but it is only fair that the standing of the service abroad should be understood and appreciated. The above editorial from an important British trade paper shows that there has been a long-time agitation here for consular reform, and that the United States service is the model.

Under date of March 24, Mr. Halstead sends a clipping from The London Times of even date showing the important work being done by the Austrian Export Association, as follows:

"AUSTRIAN EXPORT TRADE.

"[From our own correspondent.]

"Vienna, March 23.

"The annual report of the Austrian Export Association, which has just been issued, manifests a satisfaction with the commercial policy of the government which has hitherto been conspicuous by its absence among the trading classes of this country. The recent action of the Ministry of Commerce for the promotion of Austrian export trade, by the establishment of subsidized agencies abroad, is greeted with warm appreciation. It is regarded as a solution of the problem of securing a footing for the Austrian exporter in foreign countries. The report also gives particulars of commercial missions dispatched by the association last year to Mexico, Uskub, Durban, Cape Town, and Perth, in western Australia, and announces the establishment, a short time hence, of an agency at Irkutsk, in Siberia. Another feature of this society's activity during the past year was an inquiry conducted privately among the representatives of all branches of Austrian industry respecting the possible consequences of a failure to renew the Ausgleich with Hungary. The result of the investigation, which has not been made public, has been submitted to the Ministry of Commerce in the form of a memorial."

Openings for American Trade in Formosa.—The following is a copy of a letter by Consul Davidson, of Tamsui, dated March 13, 1899, to the Philadelphia Commercial Museum:

A few days ago, the Imperial Japanese Diet passed the loan bill which gives to Formosa the sum of 35,000,000 yen ($17,500,000 in United States gold) to be spent in public improvements in the island. This will undoubtedly result in an increased import trade, and it is to be hoped our manufacturers will profit by it. While the larger proportion of the above sum will be expended in railway and harbor work, trade in all lines will be stimulated, and a considerable commercial boom is to be expected during the period of construction.

A very important experiment is now being made, the success of which depends much upon assistance given by American manufacturers. I refer to the establishment in this city (Tamsui) of a general supply house, something entirely new to Formosa. Commodious quarters have been obtained, and a large sample room arranged, in which will be placed on exhibition manufactured goods of all kinds. The manager, Mr. H. W. S. Edmunds, is an experienced merchant from Japan, and he informs me it is his intention to push, almost wholly, the sale of American goods. He is desirous of entering into communication with American manufacturers, and has handed me the inclosed list of goods [published in the advance sheets No. 412], in which he thinks something may be done. He solicits from manufacturers catalogues and commercial literature, with prices and best discounts and other information necessary for effecting sales, and would like catalogues in duplicate wherever possible. He is particularly desirous of obtaining samples, and requests that same may be sent him wherever practicable. The sample room will, he believes, lead to more satisfactory results than any other method of business which he could adopt; and with this I agree wholly. Of course, there are some lines in which samples are out of the question. For such he desires photographs or other pictorial representation. The Edmunds establishment will be the only house working on this basis in the island; and, as both Japanese and Chinese like to see style of goods before ordering, I have great confidence in its ultimate success.

As to the advantage of manufacturers sending commercial literature to this consulate, I might state that catalogues which are loaned to inquirers frequently lead to sales. Requests for catalogues and information regarding certain American manufactures are often made, and, while they are mostly for single articles of machinery of no great value, still these are of importance in introducing to the island a large variety of goods which may lead to more profitable business later.

Demand for Corn in China.—A telegram has been received from Consul Fowler, of Chefoo, dated April 14, 1899, requesting cable bids for 60,000 bushels best shelled yellow corn, to be delivered in Chefoo within ten weeks. All charges are to be included in the bids, and the payment is to be made c. o. d.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 408. April 24.—*Markets of Manila.

No. 409. April 25.—Imports of Natal—*Australian Butter Trade—Meat Products of Uruguay—Mining Industry in Mexico.

No. 410. April 26.—*Proposed Department of Commerce in Great Britain—Duty on Meats in Germany—Petroleum Refinery in Norway—A New Industry in Scotland—Treatment of Insane in Belgium—Swine in Egypt—*Demand for Corn in China.

No. 411. April 27.—Russian Ice Steamer—Rubber Overshoes in Austria—Hardware in Lourenço Marquez—Wheat in Spain—Insurance and Acetylene Gas in France.

No. 412. April 28.—*Openings for American Trade in Formosa—New Cruisers in Great Britain—Flour in China—Canadian-Australian Cable.

No. 413. April 29.—Mining Laws of British Columbia.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

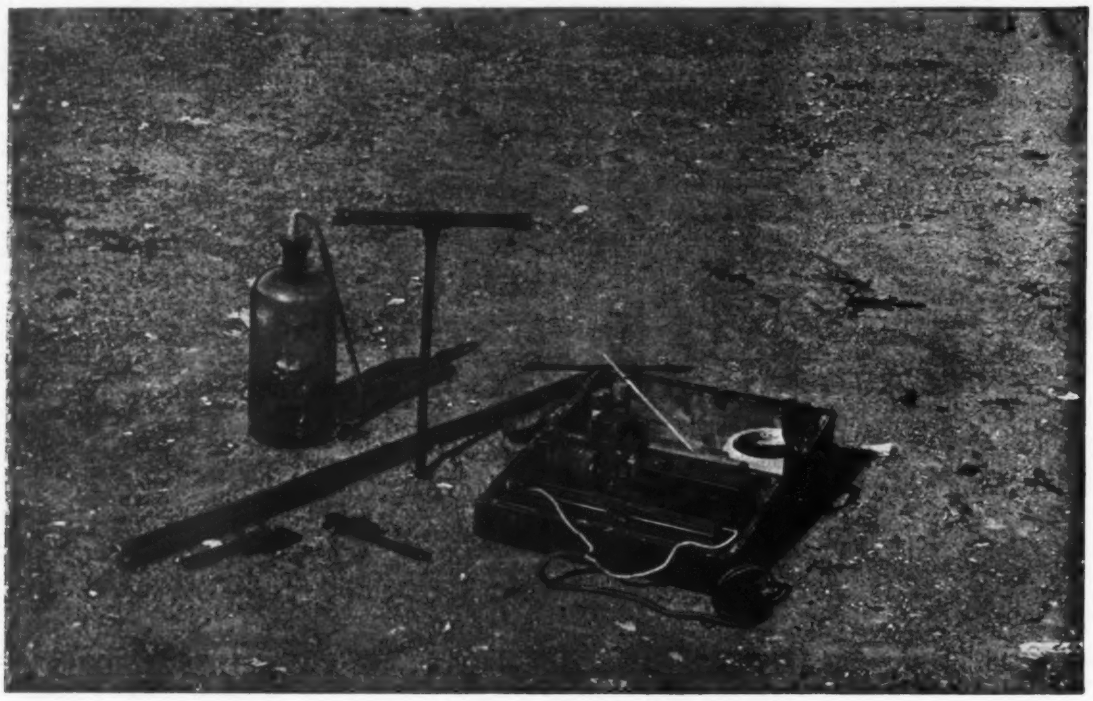
THE ALKALI SOILS OF THE YELLOWSTONE VALLEY.

THE Division of Soils of the U. S. Department of Agriculture has recently published, in Bulletin No. 14, a most interesting pamphlet written by Milton Whitney and Thomas H. Means, entitled "The Alkali Soils of the Yellowstone Valley, from a preliminary investigation of the soils near Billings, Montana." Through the courtesy of the department we are enabled to present some attractive illustrations from the Bulletin. We give the following short résumé of some of the natural features and the work which was carried on.

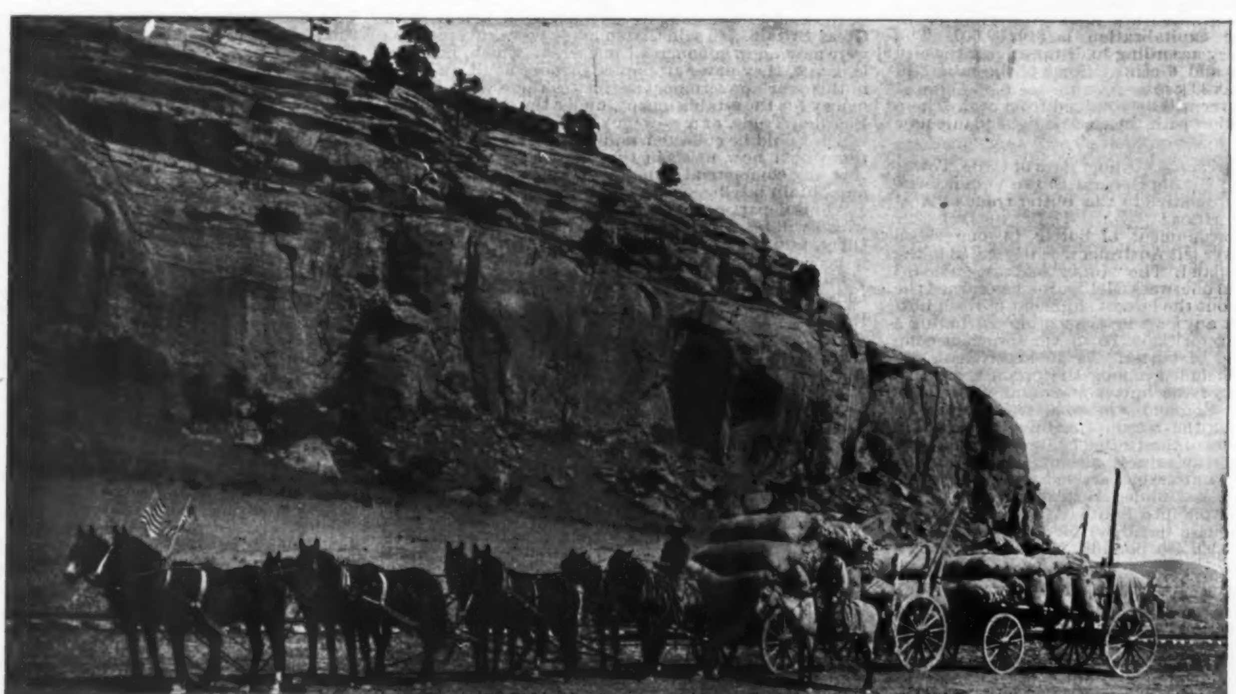
The Yellowstone Valley in Montana is approximately 400 miles in length, but the area which was specially considered in the investigations is that part of the valley between Billings and Glendive, a distance of 250 miles. The valley at this point is about 6 miles in width and irrigation has been used for twelve or fifteen years. The water for the main ditch supplying the valley at this point is taken out of the river nearly 40 miles above the town of Billings. Under the common practice of irrigation an excessive amount of water has been applied to the land and seepage waters have accumulated to such a degree that many of the waste fertile tracts on the lower levels are already flooded and alkali has accumulated on them to such an extent that they are mere bogs, and the once fertile lands are thrown out as ruined and abandoned tracts. This injury, while not very widespread, naturally greatly alarms the owners of the land. There is generally little system in the application of water to the land. Few of the planters know how much they use and none of them pretend to know how much they get. The water is applied when the surface appears dry and is then applied in such excess that much of it cannot evaporate and cannot seep down through the subsoil before the surface again dries out and a further application of water is applied by flooding. In every case, in injury to crops which was examined around Billings, the first trouble was shown to be an accumulation of seepage water near the surface of the ground. The investigations of the Division of Soils will be of the greatest value if they do not do any more than to show the full results of over-irrigation and the necessity for intelligent and careful application of water to the soil and the importance of underdrainage, where the alkali cannot be otherwise controlled or removed. Proper irrigation in an arid region furnishes an ideal condition of crop production, and there is reason to hope that the principles underlying irrigation will come to be recognized and controlled in the field as they are in the commercial greenhouses at the present time. The Division of Soils has invented an ingenious instrument for determining the moisture of soils through their electrical resistance. With this instrument the amount of fluctuations of the water content near the surface of the ground, or at any desired depth, can be readily determined, and with the use of such an instrument it is quite possible, with an irrigation plant, to maintain any desired water content near the surface and to prevent an undue accumulation in the subsoil. These instruments are supplied at such very moderate rate that fluctuations of the water content of soils can be obtained by interested parties at a minimum of expense.

Any excessive accumulation of soluble mineral salts in the soil is popularly spoken of as "alkali" in the West. The term, therefore, as popularly used does not necessarily refer to material of an alkaline or basic nature. The alkaline soils of the West are of two classes: the alkaline carbonates or black alkali, usually sodium carbonate, which is the worst form of alkali, actually dissolving the organic materials of the soil and corroding and killing germinating seed or roots of plants; white alkalies, the most common of which are sodium sulphate, sodium chloride, magnesium sulphate, magnesium chloride, and occasionally some of the borates. These are not in themselves poisonous to plants, nor do they attack the substance of the plant roots, but are injurious when, owing to their presence in excessive amounts, they prevent the plants from taking up their needed food in water supply. Soils are derived from the disintegration and decomposition of rocks. During the weathering process the rock crumbles and breaks down into minute particles composing the resultant soil, while the rock itself is hard and continuous, but has little appreciable space for the absorption of water, and yet the resultant soil is permeated with air spaces aggregating about 50 per cent. of the bulk of the soil. During the weathering process, therefore, and specially in the slow decomposition of the minerals of the rock or soil, certain portions, and in the aggregate very large portions, of the rock are rendered soluble and accumulate within the soil as soluble salts, or are carried off in the solution washed off into the ocean or some inclosed basin which receives the drainage waters of the district.

In the arid portions of the country under scanty rain fall there is not sufficient underdrainage seepage waters to carry off the amount of salts rendered soluble in the decay of rocks, and we have, therefore, as a rule, a much larger soluble salt content in soils of arid regions than in the soils of humid regions. The very fact of the easy solubility of the salts renders them dangerous in the practice of agriculture when they accumulate as in the soils of the arid West. In the humid regions the salts are removed by leaching almost as rapidly as the disintegration of the rocks proceeds, and there is little evidence in the soil of their former existence. Where the rainfall is slight, as in the arid



FIELD APPARATUS USED IN SALT DETERMINATIONS.



A NEAR VIEW OF THE SANDSTONE BLUFF ON NORTH SIDE OF THE YELLOWSTONE VALLEY.

regions, and the leaching of the salts and the underlying rocks is small, the removal of soluble matter has not gone on to such a degree. Immediately below the surface there are evidences of their presence, and in localities of very small rainfall and very scanty drainage, and where the evaporation of the soil moisture has been excessive, the salts often appear as an efflorescence on the surface of the ground. The source of alkali salts at Billings is in the shale forming the bluffs on the south side of the valley, rather than in the sandstone of the north bluff, which is shown in our engraving.

The Yellowstone River at Billings traverses a broad valley from six to ten miles wide. The valley is bounded on either side by high bluffs. On the north side the bluff is of sandstone and on the south side steep, ragged hills of blue shale. The sandstone is a gray, siliceous stone, rising abruptly to a height of from 200 to 500 feet above the general level of the valley. Small, but perceptible quantities of magnesium and sodium sulphates are to be found throughout the sandstone rocks and where evaporation has gone on from the surface for a considerable time, while crusts of these salts form on the surface. Water seems to percolate through fine veins and cracks in the rocks and issues at the sides and the foot of the bluffs, in many places giving rise to springs of alkali water containing a greater or less amount of soluble sulphates. The main body of sandstone has been eroded rather unevenly and the peculiar pinnacle-shaped structure is seen that is so characteristic of the "Bad Lands." The face of the bluff is completely rounded by weathering, and the general ragged character is smoothed off by the continual falling of the debris due to the rapid disintegration of the rock freely exposed to the weathering influences. Underlying the sandstone and coming out from under the bluff, there is a fine blue shale or slate which extends to an unknown depth. The shale rises up from beneath the sandstone and forms the rough angular blue hills on the south side of the valley. The shale is penetrated with numerous fine cracks and joints running in all directions, and these are filled with gypsum and calcium carbonate. The weathering of these two rocks, the sandstone and the shale, has given rise to the soils of the valley and they are themselves the present source of soluble salts in the valley; as the rocks weather, a portion of the soluble salts is removed in the springs and seepage waters, but the removal is not nearly so complete as is the case in the humid portion of the United States, because the small rainfall renders the escape of all of the excessive amount of salt impossible. These two types of rock give rise to two distinct types of soil in the valley—the first is a sandy soil, derived from the disintegration of sandstone rock, giving a soil of open texture, easily worked, in which there is less trouble from alkali on account of more perfect drainage and less risk of accumulation of seepage waters; the other type is a stiff clay or "gumbo" formed from the disintegration of the shale. The shale soils are extremely fertile when in good condition, but are quite difficult to work. They are easily puddled and are rendered almost impervious to water by the excess of soluble salts which they usually contain, and it is upon these soils with their poor underdrainage that the greatest amount of trouble has arisen from the accumulation of seepage waters and salts in the over-irrigation of the soils in the valley.

The method used by the Department of Agriculture in determining the soluble salt content of the soils in the valley is interesting. Briefly, the method consists in taking a sample of soil with an auger at any desired depth in the field, adding sufficiently distilled water to thoroughly saturate it, bringing it into the consistency of a thick paste. This is then filled into a hard rubber cell with electrodes, and the electrical resistance of the saturated soil can be taken as the resistance of a salt solution filled with inert grains of soil. The effect of the soil grains is to increase the resistance about 100 per cent. This effect is constant for all ordinary soils. The resistance of the soil moisture can be calculated by multiplying the resistance of the cell by this factor and reducing for temperature, which has previously been determined. This will give the resistance of an amount of soil solution equal to that in the cell and without the presence of the soil. The specific resistance of this solution can then be determined, and by comparing this with the specific resistance of solution of different strength of sodium chloride or of any other salt, the actual amount of salt can be determined in terms of the salt used as a basis for comparison. Our engraving shows a complete outfit for the determination of the soluble salt content of the soils, as actually used in the field. The sample is taken out with an auger, mixed in the field in a porcelain dish, with distilled water, filled into a hard rubber cell and the resistance is then taken. The temperature of the cell is also taken. The calculation can be made on the spot or at any subsequent time. If the amount of moisture added is once actually determined, the variations in the amount added in different experiments have very little value. The moisture determinations do not, therefore, have to be made in each case. The method is extremely sensitive and is very rapid. The determinations can be made by one man quite as fast as the samples can be drawn by another, and much faster if the ground is hard and dry.

In carrying out the investigations three lines of borings were run; one of five miles in length and the others, for more detailed study, of about 1½ and 1¼ miles respectively in length. The longer section began above the ditch and went down toward the river; the others extended from an alkali flat and from a drainage ditch back into the higher levels. These borings were all numbered and their position accurately marked on the working maps. In addition to this, a section or square mile of land was studied in great detail and borings were made at frequent intervals to a depth of 10 or 15 feet. A number of special borings were also made to study the relation of the different types of soil to the amount and distribution of the salts.

The results of the investigations have been illustrated by graphic diagrams in the Bulletin to which we have referred. The investigations point clearly to the natural methods of preventing this injury by over-irrigation and of reclaiming the lands when once the injury has occurred.

The logical method of reclaiming consists in providing an adequate system of drainage to carry off the excess of water and the accumulation of soils. This is expensive, but is the only thing in this case to hasten the slow process of nature, which is entirely inadequate in the presence of the present methods of irrigation and of culture. Under-drainage is expensive, but it has amply repaid for the investment in other localities where the land is worth no more than in the Yellowstone Valley. The report is valuable as showing what care the government exercises over the farmer of the United States. All the resources known to modern science are placed at his disposal, and the greatest specialists in the world in their respective lines are constantly ready to come to his aid. The wise and liberal policy of the government as exemplified by the Department of Agriculture might well be emulated by other countries.

ONE OF THE IMPORTANT INDUSTRIES OF THE YELLOWSTONE VALLEY—FEEDING OF SHEEP AND RANGE CATTLE DURING THE WINTER SEASON.

The subject of coal consumption in steam turbines is interesting, and entitled to some attention. Recent figures show that the new engines will consume 15 per cent. less coal than ordinary engines traveling at the same speed; and as the vessels and the engines increase in size, so does this difference increase—that is, the higher the tonnage, the greater is the superiority of the turbine to the ordinary engine in this respect. This, of course, means that less coal need be carried than for the ordinary engine for the same rate of speed; but it must not be forgotten that every knot which is added to the speed means, for any description of engine, a larger proportional increase in coal consumption the faster the boat is driven, and, although the turbine engine will consume less than the ordinary engine, the amount of coal required to sustain a speed of 35 knots is prohibitive of long journeys so far as small vessels are concerned.

ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.*

By PHILIP DAWSON.

THERE is no longer room for doubt that electricity is the one pre-eminently successful motive power for tramways. This is proved by the rapid growth of electric traction. The words "experimental line" have fallen out of use, yet it is only a few years ago that those who ventured to foretell that the trolley system would be generally introduced into this country were ridiculed. There is no country in which electric traction is advancing more rapidly, and in which finer plants are being installed than in Great Britain. The day is not far off when horses and steam will have disappeared from the streets as far as tramways are concerned, and when the horse 'bus as a competitor will be no longer known.

The problem of greatest importance, however, in which electric traction will be a principal factor, is the rapid transportation of large crowds from and to their business in our cities. The object of this paper is to investigate in a general way the special requirements of this service and to demonstrate the special adaptability of electric traction to it.

It is evident that the only solution of rapid transit lies in railways which must be either overhead or underground, and of both London possesses a greater mileage than any other town in the world. The factor of initial expenditure must restrict the number of tracks available for the up and down traffic.

The stopping places on such lines must of necessity not be far apart, and to diminish the crowds on the platforms and to increase the number of passengers the trains must follow each other with the greatest possible frequency. Consequently the average speed of the trains must be increased as much as possible without unduly diminishing the distance between two consecutive trains, which would be dangerous.

Steam locomotives have probably reached their approximate maximum development, and the results so far obtained with them for the class of traffic in question are far from satisfactory. They do not get up speed rapidly, owing chiefly to the torque on the driving axles constantly varying in consequence of the reciprocating motion of the pistons. They are not economical, as their fuel consumption is practically the same whether they are exerting their fullest power, coasting, or standing still, and their maintenance is very costly.

There is a commercial limit as far as distance is concerned beyond which transmitting power electrically will not pay. But that limit varies with each case, and cannot be ascertained except by the most careful calculation after all the conditions that obtain have been minutely examined. England was the first country to introduce electric traction on railways, both underground and overhead, as instanced by the City and South London, and Liverpool overhead electric railways. But, to prove commercially that very much heavier traffic could be handled, that much greater distances could be traversed, and to develop on a large scale the necessary machinery was again left to America, and hence the necessity of being practically confined to American experience and examples in this paper.

There are practically three methods of handling electrically the traffic on a railway, namely:

1. By locomotives or motor cars hauling a train of trailer cars.
2. By independent motor cars.
3. By a set of independent motor cars formed into a train and handled from the front car or from a so-called controller car. Each car, however, can be separated from the train, and it then becomes an independent motor car.

As regards the supply of the necessary current for the motors, there are three distinct methods:

First. By accumulators or storage batteries, which

* Lecture delivered before the Society of Arts and published in The Journal of the Society.

may be carried either on the motor car or locomotive, or on a tender.

Secondly. By having a car containing a stationary engine, dynamo, and boiler, which supplies the necessary current to the motors on the cars comprising the train of which it is part, and as proposed by W. Heilmann.

Thirdly. By continuous or multiphase current supplied directly from a generating station or from a substation which, in its turn, gets its supply of energy from the main station, the current being distributed either in the form of direct or polyphase to conductors running along the lines, and from which the power is supplied through sliding contacts on the cars to the motors.

The two former methods, as far as this paper is concerned, will not be discussed, as sufficient data are not available to justify their being considered.

The system of transmission of energy to the motors by means of conductors laid along the track will therefore alone be considered.

This method allows of several variations as far as the generation and distribution of power is concerned, among which the chief may be set down as follows:

(a) One continuous current generating station supplying current direct to contact rail. Where drop in pressure owing to distance becomes excessive, a negative "booster" may be used; it serves, so to speak, to pump back the current to the station, and is self-regulating, not taking at any period more power than is actually required to pump the current back. Should there be one or two lines too long to enable them to be worked this way, polyphase high tension generators should supply the power to one or more sub-stations along the line, as may be found necessary, in which rotary converters are located, which transform the current back into continuous. The polyphase generators to be driven by continuous current motors in the generating station. As an example of such a station, the new Dublin tramway power house may be taken.

(b) One central station generating continuous current with sub-stations in which accumulators are located along the road, and which are charged by means of a booster and special cables. As an example of this system, the Leeds tramways may be taken as designed by, and carried out by, the late lamented Dr. John Hopkinson.

(c) A series of stations, as described under (a) and (b), situated at various distances and connected together one with the other. As an example of this, the tramways and light railways in and round Boston, Mass., may be taken, owned by the Boston Elevated Railway Company, which has absorbed the well known West End Company.

DATA OF BOSTON ELEVATED RAILWAY.

Track miles operated	305
Number of cars	2,648
Car miles run during 1898	29,787,000
Passengers carried during 1898	172,764,300
Number of power stations	5
Total capacity of power stations in kilowatts	16,100
Total rated indicated horse power of engines	24,000

(d) A power station generating polyphase currents, which, by means of static step-up transformers, are transmitted at tensions which run from 2,500 to 40,000 volts to sub-stations where static step-down transformers reduce them to pressures of 300 to 350 volts; the current at this pressure enters rotary transformers, which deliver direct current at 500 to 550 volts to the line. As an example of this later system, the Central London Railway, which is now under construction, may be mentioned.

(e) A three-wire system with continuous current, the rails or return forming the neutral wire. This has been tried and found wanting, and the engineers of the Central London Railway most carefully investigated its possibility and decided in favor of polyphase transmission and rotary converters, and rightly so.

From careful calculations and the investigation of what has been done both in Europe and America, there is no getting behind the fact that for any power station which will exceed 4,000 kilowatts in capacity, the polyphase system is nearly certain to prove commercially the only admissible one. This statement is upheld by such an authority as Mr. H. F. Parshall, M.I.C.E. It is evident that in the particular cases at present under consideration (suburban and metropolitan communication), more than 4,000 kilowatts will be under consideration, and, therefore, nothing, as far as the power station and transmission is concerned, but polyphase currents will be considered.

There are two distinct varieties of service to be catered for. One that on a system like the Metropolitan and District, where the stops are frequent and the runs short. The other the case of long distance lines with few stops. In the present paper it is only proposed to consider the first variety. In this case the use of polyphase motors need not be considered, as, for work entailing frequent stopping and starting, they have not up to date proved satisfactory.

A short examination of the importance of rapid acceleration on lines having stopping places at short intervals is interesting. Practical experience with electrically driven motor cars or locomotives on the experimental track of the General Electric Company, at Schenectady, has proved that it is perfectly feasible to attain a speed of 30 miles an hour 10 seconds after starting from a standstill. Assuming a level track, and that during 65 seconds the current is cut off and the train allowed to coast, that the brakes are then put on, the train will be brought to a standstill 15 seconds later, and the total time from start to stop will be 90 seconds. Under these conditions it will be found that the average speed will have been 23·16 miles an hour, and that the total distance run will be about 0·55 of a mile. Assuming that instead of attaining the 30 miles an hour in 10 seconds, it took 30 seconds, and that this full speed of 30 miles an hour was kept up for 40 seconds longer, and the brakes then put on, the train would be brought to a standstill in 90 seconds, and the average speed would work out as 21·66 miles an hour, or an average speed of about 10 per cent. less than in the previous case, the consumption of power, however, being much greater.

It is evident that the most important point is to attain a high average speed, and to keep the maximum speed attained as low as possible, as by so doing less power is required in braking the train, and also less power is required to run the train. The time between the moment when the maximum speed is attained and when the brakes are put on should be at least from 4 to 6 times that required for stopping the train, so as to allow for errors in judgment on the part of the driver, and also to enable him to make up lost time. On the Manhattan Elevated Railway, in New York, the trains, which are drawn by steam locomotives, take 20 seconds to attain a speed of 14 miles an hour, or less than half the speed in double the time as compared with electric traction just mentioned.

A much larger current will be required to attain a rapid acceleration than to attain a slow one, but the current will be required during a much shorter time, and the total energy supplied will be less in the case of rapid than of slow acceleration. This fact must not be lost sight of when calculating the feeders for such a system, and the train service should be arranged in such a way that as few trains as possible start together. Furthermore, the more rapid the acceleration required, the larger will the motors have to be, and, therefore, there will be a limit, above which it will not be advantageous to push the rapidity of acceleration. In new tunnel lines, such as are now being constructed all over London, it will be evident that it is an advantage to have the stations built with a down grade for the trains to start, so as to help the motors and reduce the current required at starting, and that similarly it will be an advantage to have an up grade when nearing a station, so as to reduce the amount of power required in braking. By properly choosing these gradients, it is found that a total economy of from 40 to 50 per cent. in the total power required by a train may be made. According to Mr. Potter's tests, it was found that during acceleration an average power of 32 amperes per ton of weight of train was required.

With a complete train composed of one motor car and two passenger cars, weighing complete 148,000 pounds, a maximum horizontal effort of 9,750 pounds was required in acceleration, the maximum current was 780 amperes at 500 volts, the maximum speed attained was 32 miles an hour, and the time taken to attain the speed was 34 seconds, the motor car being equipped with two 200 horse power motors.

METROPOLITAN ELEVATED, CHICAGO.

Number of Cars in Train.	Average Speed (not including stops) in Miles per hour.	Average Current (not including stops) in Amperes.	Board of Trade Units Delivered at Switchload per Ton Mile.
4	14·4	148·7	·050
4	14	153·2	·053
4	14·5	151·8	·050
3	14·7	137·4	·063
3	15·1	135·6	·058
2	15·3	90·1	·058
2	16·8	106·6	·059
4	12·2	101·1	·042

Railway Co.	No. of Cars.	Weight of trains in lbs.	Tractive effort per ton. Maximum for given time.		Average for total time.		Maximum speed in miles per hour.	Distance run.
			sec.	lbs.	sec.	lbs.		feet.
Metropolitan Elevated, Chicago ...	2	88,000	10	177	40	107	34·8	1,020
Lake Street Elevated, Chicago ...	2	88,000	10	135	40	84	27·6	870
Alley Elevated, Chicago	3	144,000	10	135	40	98	28·6	840
Illinois Central, Chicago	4	300,000	10	95	40	79	25·60	750
Manhattan Elevated, New York.	4	190,000	10	88	40	67	21·00	615

In another case, with a train composed of one motor car, equipped with two 125 horse power motors and one trailer car, the total weight of train being 103,000 pounds, a maximum speed of 31 miles an hour was attained in 37 seconds, the maximum current being 500 amperes and the maximum horizontal effort required to attain acceleration 5,640 pounds. In a series of tests made on the Nantasket Beach line it was found that with a heavy motor car, 51 feet in length over all, carrying 100 passengers, weighing 21 tons, on an average distance of 2,980 feet between stations, a maximum speed of 40 miles an hour was attained, the average speed being 18 miles per hour, and the power required was 0·098 Board of Trade unit per ton mile.

In an experiment with a train composed of one motor car and one trailer car, weighing 57 tons, with an average distance between stations of 4,280 feet, a maximum speed of 37 miles was attained, the average speed being 17 miles an hour, the power required being 0·067 Board of Trade unit per ton mile.

From a comparison of the actual results obtained on the elevated electric railways of Chicago and on the Metropolitan and District line in London, we see that whereas the maximum speed of 25 miles an hour is obtained in 10 seconds with electric traction, it takes 33 seconds to do it with steam locomotives, and that while the electrically propelled train could do the distance of 1,880 feet in 66 seconds, with steam it would take 93 seconds, or nearly half as much time again. If in the case of electric traction the power is cut off the moment the maximum speed of 25 miles an hour is obtained, and the train allowed to coast before the brakes are put on, the distance considered would be done in 76 seconds. The steam-driven train even then would take more than 25 per cent. more time to do the same distance.

Having tried to show the advantages which electric traction possesses as regards the possibility of increasing the frequency of the trains without decreasing the factor of safety, namely, the distance between two trains, it may be advantageous to see how, from an economical standpoint of generating power, electricity is a cheaper method of operation than steam locomotion. An electrically driven train only requires one man instead of two to drive it, and when the train is not running no power is consumed and no coal or water wasted. Steam locomotives, it is well known, use but very little less coal and water when they are standing still than when they are running, and are much less economical, consuming, as they do in America, from five to six pounds of coal per indicated horse power. On main line English roads it is stated that three to four pounds are consumed, and taking an average power of 400 horse power per locomotive, and a train plus engine weighing 250 tons, at a speed of 40 miles an hour, we get at the most economical rate about 0·65 pound of coal per ton mile, or, compared to the electric power required by electric traction, 13 pounds of coal per Board of Trade unit required, which is enormous; under favorable conditions it would not take much over 3 pounds of coal to give one Board of Trade unit at the switchboard. A properly designed electric station with large units would probably never consume more than 2 pounds of coal per indicated horse power hour, or 2·65 pounds per kilowatt hour at the switchboard, and engines of the size of 4,000 to 6,000 horse power would be guaranteed to consume not more than 12 pounds of steam per indicated horse power hour. A large station would fully justify a comparatively large initial expense in coal handling and stoking machinery, and the location of the station could be chosen so as to be most advantageously situated as regards both coal and water, the coal without being handled being taken from either the ship's hold or the railway truck, conveyed automatically to the coal stores, and from thence automatically to the fires, the ashes being conveyed away automatically as well. In such a station but very few men would be required, and the cost of power could be reduced below one halfpenny per Board of Trade unit, including expenses of every kind.

DISTANCE 2,000 FEET, TO BE RUN OVER IN 75 SECONDS, OR AT AN APPROXIMATE AVERAGE SPEED OF 16 MILES PER HOUR.

Time during which power applied in seconds.	Maximum speed attained in miles per hour.	Time during which brakes applied.	Average power-consumption, per ton, in B.T. units.
7·5	25·75	10·0	0·035
12·5	26·00	10·5	0·036
16·5	26·25	11·5	0·038
24·5	27·15	12·5	0.0475
31·0	28·25	14·0	0·0480
39·0	30·50	17·0	0·0575
53·0	36·50	22·0	0·0840

Distance to be run 2,000 feet.

Tractive effort per ton in lbs.	Maximum speed in miles per hour.	Time in seconds during which brakes applied.	Time in which 2,000 feet run.	Average speed in miles per hour.	Board of Trade units per ton mile.
	62·5	41·0	41·0	33	0·300
300	53·0	34·0	52·0	26	0·196
150	46·0	26·0	58·0	23	0·160
100	40·0	24·5	67·5	20	0·130
65	34·0	22·0	82·0	17	0·100
45	27·5	15·0	98·0	13¾	0·075
35·6	23·0	12·0	127·0	10½	0·057
27·6	17·5	11·0	160·0	8	0·045

Comparing again the coal consumption per train mile on large English main line railways, which varies from 35 to 58 pounds of coal per train mile, we get a coal consumption of from 0·146 to 2·32 pounds per ton mile, corresponding to 28·12 to 46·4 pounds per Board of Trade unit, required to be generated at the power house. The following results actually obtained with slow speed Corliss type engines and standard American railway generators may be of interest:

Total coal consumed, Brooklyn City Railway Company, per Board of Trade unit, 3 pounds.

Total cost, everything included, of Board of Trade unit at switchboard, 0·5195 cent (about one farthing).

Cost of coal per unit, 0·2307 cent, about 0·166 of a penny; Union Traction Company, Philadelphia.

Poorest coal, 3½ pounds consumed, per Board of Trade unit at switchboard.

In another case cost of coal 0·272 cent per Board of Trade unit at switchboard, about 0·186 pence.

Total cost of unit, all included, 0·591 cent, about 0·296 pence.

Coal consumption in another case with Corliss engine, average for one year, per indicated horse power hour, 1·65 to 1·76 pounds.

What good slow speed Corliss engines, properly designed for railway work, compared to other engines mean is shown by the fact that by such a change in a large American station the coal consumption was reduced from an average of 8·3 to 4·9 pounds of coal per car mile.

From a series of figures obtained from the various Chicago electric overhead lines, from 0·16 to 0·135 Board of Trade unit is required at the switchboard to drive the trains, the average speed of the trains being 13¼ miles an hour, and the maximum speed obtained varying from 28 to 35 miles an hour.

The coal and water consumption, per Board of Trade

unit, must necessarily be very low, the losses in the step-up and step-down transformers and in the transmission and rotary converters would not be very great, and it would be perfectly feasible to attain an efficiency of 60 per cent. at the motor terminals and of 50 per cent. on the power applied to the car axles. Large engines and large generators and converters are designed so as to take an overload of 25 per cent. for any period of time, and be capable of overloading 50 per cent. for a short time without injury, and by a selection of proper units a very large economy could be attained.

METROPOLITAN ELEVATED, CHICAGO.

Length of street	36¼ miles.
Average distance between stations	1,600 feet.
Time interval between consecutive trains	2½ minutes.
Average speed in miles per hour	13 miles.
Maximum speed	28 "
Total rated power of generating station	5,000 kilowatts.

SOUTH SIDE ELEVATED, CHICAGO.

Length of street	18½ miles.
Average distance between stations	1,720 feet.
Time interval between consecutive trains	1½ minutes.
Average speed in miles per hour	14 miles.
Maximum speed in miles per hour	26 "
Total rated power (4 units 800 kilowatts each) of generating station	3,200 kilowatts.

LAKE STREET ELEVATED, CHICAGO.

Length of line	15 miles.
Power of station	3,000 kilowatts.

NORTHWESTERN ELEVATED, CHICAGO.

Length of line	15 miles.
Rated power of station { 3–1,500 kilowatts. 1–800 " }	5,300 kilowatts.

LOOP, CHICAGO.

Length	4 miles.
Rated capacity of station { 4 units 1,500 kilowatts. }	6,000 kilowatts.
Number of trains passing over line in 24 hours	3,000 trains.
Total rated power of Chicago elevated lines, approximately	22,500 kilowatts.

NANTASKET BEACH.

Length of line	20 miles.
Rated power of station	1,800 kilowatts.
Average distance between stations	4,280 feet.
Maximum speed per hour	43 miles.
Average speed	25 "
Board of Trade unit per ton mile, at switchboard	0·0808
Weight of two-car train	55 tons.

The elevated railroads of New York and Brooklyn have been losing business during the last few years so rapidly that the financial condition of the Brooklyn system is serious, and the return on investment of the New York system much reduced, and is still declining. The elevated railroads of Chicago have never been able to earn a satisfactory dividend. The general introduction of electricity in the Chicago system has greatly improved the Chicago situation, in spite of the competition of the surface trolley lines, which parallel the elevated lines in most cases. The elevated railroad problem is resolved into a discussion of speeds, station frequencies, and relative costs of service. Any railroad of this class which aims to maintain a high schedule must choose a motive power in which the possibilities of rapid acceleration are a maximum, and, all other conditions being equal, should choose that particular motive power which will bring about the quickest acceleration consistent with due economy.

The Manhattan system is a comparatively simple one, with four main through lines, without branches of importance, while the Brooklyn and Chicago systems are composed of trunk lines with branches, involving more or less complicated switching arrangements. Until about a year ago, the three Chicago companies, the Lake Street, the South Side and the Metropolitan, had independent termini in the business heart of the city. Now, however, the newly constructed "Loop," encircling the business district, is used as a terminus for all three lines and for a fourth, the Northwestern, now under construction, and all the elevated trains of the city pass round this loop on each trip. The Brooklyn elevated system has lately secured a new terminus on the Manhattan Island side of the Brooklyn Bridge, and experiments are being made with a view to converting the entire Brooklyn system to electricity in the near future. The entire New York system, however, is at present operated by steam locomotives.

The little locomotives in use on the New York system weigh 47,000 pounds, of which 31,500 are on the four 42-inch driving wheels and 15,500 are on the four 30-inch truck wheels. The total wheel base is 193 inches, of which 60 inches is rigid. The cylinders are 12 inches in diameter and have a 16-inch stroke. The grate area is 16·5 square feet, and the total heating surface is 4,034 square feet. There are 154 flues 1½ inches in diameter and 75 inches long.

The standard Manhattan car weighs 29,088 pounds, has seats for 48, and frequently carries 100 passengers. It is mounted on eight 30-inch wheels.

The total weight of a 5-car loaded Manhattan train is about 130 tons. The weight on the drivers is 12 per cent. of the total train weight, and with 25 per cent. adhesion, the maximum drawbar pull possible for the locomotive to exert is 7,875 pounds.

The electric locomotive car of the Metropolitan Elevated Railway Company, of Chicago, weighs 53,200 pounds complete with motors, or 40,000 pounds exclusive of motors. It is a standard American passenger car with full seating capacity, about one-half of each platform being taken up with the cab and necessary controlling apparatus. The trail cars weigh 33,000 pounds. The seating and standing capacity of both motor and trail cars is approximately 90 passengers. The average 4-car heavily loaded train will weigh about 100 tons, of which 32·5 tons approximately are on the four wheels of the locomotive's motor truck and 67·5 tons are in the trail cars. From 30 to 35 per cent. of the entire train weight is available for traction under these conditions, and the maximum drawbar pull possible to exert without slipping of wheels is about 16,250 pounds.

The South Side Elevated Railway Company, of Chicago, is equipped with the Sprague multiple unit system, by means of which two or more cars in a train are equipped with motors and may be operated in unison by a single controller from any point in the train. The company is now operating 4-car trains on each of which is a motor truck carrying two motors. The cars weigh about 20 tons each without load, and about 60 per cent. of the train weight is available for traction.

easy to ascertain that this would greatly increase the average speed and therefore decrease the time necessary to do the distance.

The characteristic difference between the acceleration curve of a train hauled by a steam locomotive and one driven electrically is that, whereas the acceleration where steam is used as motive power increases at first, slowly following a curve which is nearly tangent to the horizontal or time axis, the acceleration curve in the case of electric propulsion is represented by a straight line rising very rapidly, and forming a very small angle with a vertical axis.

It may be interesting to mention a few details regarding the two large power stations which are now

American Rating.			H.P. Imputed.	Amperes (Full Load).		Full Load.	Commercial Efficiency.		
Poles.	kw.	Speed. Revs. per Minute.		500 Volts.	600 Volts.		75 % Load.	50 % Load.	25 % Load.
6	165	200	237	300	275	93½	93¼	92½	89
6	225	200	321	410	375	94	93¾	93	89½
6	225	150	321	410	375	94	93¾	93	89½
6	225	120	321	410	375	94	93¾	93	89½
6	325	100	464	590	542	94	93¾	93	89½
6	325	150	464	590	542	94	93¾	93	89½
6	425	150	607	773	710	94	93¾	93	89½
8	425	120	607	773	710	94	93¾	93	89½
8	425	100	607	773	710	94	93¾	93	89½
8	425	80	607	773	710	94	93¾	93	89½
8	525	125	750	956	877	94	93¾	93	89½
10	525	100	750	956	877	94	93¾	93	89½
10	525	90	750	956	877	94	93¾	93	89½
10	525	75	750	956	877	94	93¾	93	89½
12	850	120	1,206	1,545	1,420	94½	94¼	93¾	90
12	850	100	1,206	1,545	1,420	94½	94¼	93¾	90
12	850	80	1,206	1,545	1,420	94½	94¼	93¾	90
12	1,050	80	1,482	1,910	1,755	95	94¾	94	90¼
12	1,200	80	1,698	2,180	2,000	95	94¾	94	90¼
16	1,600	75	2,260	2,910	2,670	95	94¾	94	90¼

There are, therefore, three distinct types of elevated railway equipment, the steam locomotive using 10 to 15 per cent. of the train weight for traction under heavy traffic conditions, the electric locomotive using 30 to 35 per cent., and the multiple unit system using any amount desired up to 60 per cent. of the train weight.

The transportation expenses of the South Side Elevated Railway, in Chicago, for July, August, and September, 1897, when steam locomotives were employed, were 2·8 cents per car mile, while in the same months of 1898 they were 1·9 cents per car mile, or a saving of nearly 0·9 cent, or about 33 per cent.

METROPOLITAN DISTRICT, LONDON.

Average speed in miles per hour	13½
Maximum " "	27
Minimum time between consecutive trains	2 minutes.
Average time between consecutive trains	3½ to 4 min.
Total weight of train	161 tons.
Average carrying capacity	450 passen.
Weight of locomotive	47 tons.
Average distance between stations	2,600 feet.
Time required in seconds to reach 25 miles an hour starting from a standstill	30 seconds.

The figures in the above table show at once the great advantage to be gained by electric traction, by means of which speed of 25 miles an hour could be obtained in 10 seconds, and by simple calculation it is

being equipped in New York, and which will operate the two large tramway systems of that city, namely, the Metropolitan and the Third Avenue. The Metropolitan station is now under construction, and will contain eleven direct connected sets each of 3,500 kilowatts, room for extension being allowed, and a capacity having been foreseen of nearly double that amount. The following gives the particulars of the General Electric Company's dynamos which will be used.

The machine will have a frequency of 25 cycles per second, at 6,600 volts. It will have 40 poles, and will run a speed of 75 revolutions per minute. It will be of the stationary armature type, the core being built up of laminations 0·014 inch thick. Each lamination has two dovetail projections which fit in corresponding slots in a heavy cast-iron spider. Spaces are left between the laminations at intervals through which currents of air are driven by the rotating field and circulating by intimate contact with core and windings. The armature winding consists of form-wound coils placed in slots in the core and retained by wooden wedges, the edges of which fit into recesses in the teeth. The field frame consists of a cast-steel ring supported upon a cast-iron spider. To this are bolted laminated core of sheet iron, the pole pieces of which project over and support the copper field windings. The field winding consists of copper strip wound on edge with paper insulation between turns. The insulation is such as to stand a test of 4,000 volts alternating between the winding and the core. The exciting E. M. F. is 125 volts. The collecting rings are of copper, and carbon brushes are used. The armature winding is tested to 12,000 volts alternating. The temperature rise of the

Approximate Weight of Armature and Commutator.	Approximate Weight of Generator Complete.	Diameter of Shaft in inches.	English Rating at 500 Volts Constant Potential.			
			Classification.	Amperes. Full Load.	Approx. H.P. to Drive.	Approx. Weight of Steam-engine in lbs.
6,000	13,100	9	150 – 200	300	212	42,500
7,000	21,000	9 – 10½	200 – 180	400	285	50,000
13,900	34,300	9 – 11½	200 – 135	400	285	55,000
14,520	37,000	9 – 11½	200 – 110	400	285	85,000
17,000	45,500	9 – 11½	300 – 135	600	428	144,000
21,000	61,000	11½ – 14	300 – 90	600	428	85,000
25,500	60,000	14 – 16	385 – 135	770	550	94,000
29,000	65,000	14 – 16	385 – 110	770	550	100,000
31,000	72,000	15 – 18	385 – 90	770	550	180,000
32,000	75,000	15 – 18	385 – 75	770	550	198,000
31,000	72,000	16 – 18	480 – 115	960	685	181,000
27,000	69,000	16 – 18	480 – 90	960	685	187,000
32,500	76,600	16 – 18	480 – 80	960	685	192,000
36,000	87,000	16 – 18	480 – 70	960	685	198,000
40,000	100,000	19 – 22	800 – 110	1,600	1,135	215,000
44,000	107,000	19 – 22	800 – 90	1,600	1,135	237,000
47,000	116,000	19 – 22	800 – 75	1,600	1,135	285,000
55,000	130,000	22 – 25	950 – 75	1,900	1,341	300,000
68,000	158,000	24 – 27	1,100 – 75	2,200	1,556	415,000
70,000	160,000	24 – 27	1,500 – 70	3,000	2,120	460,000

machine after ten hours' run at full load is well under 40° C. The efficiencies are as follows:

	Per cent.		Per cent.
1¼ load	90	½ load	92·5
Full load	95·5	¼ load	88
¾ load	95	Inherent regulation	9

The steam engines which drive these dynamos are cross compound Allis vertical engines, 46 inches high and 86 inches low pressure cylinders, and 60 inches stroke. They will develop 4,500 indicated horse power at the rated economical load, and will be able to work continuously at 6,000 horse power if required, and for a short space of time they are to be able to work at 7,000 horse power. The crank shaft is of solid steel, bored and forged, with a hole 16 inches diameter the entire length, and it is 37 inches in diameter where the wheel and armature are located. The diameter of the shaft in the bearings is 34 inches and the length of the bearings 60 inches. The fly wheel will have cast steel centers, and the rim will be built up of steel plates riveted together. The rim will weigh 225,000 pounds, and the engine itself, complete, about 600 tons, and it is believed that as good results as 12¼ pounds of steam per indicated horse power will be easily obtained. There will be several sub-stations in which will be located step-down transformers of 300 kilowatts each, which will lower the voltage from 6,600 volts to 350 volts. At this pressure the current will enter rotary converters of 900 kilowatts each, and will be delivered in the shape of a continuous current of 500 volts to the tramway system.

This company operates some 250 miles of tracks and carries approximately 250,000,000 passengers every year.

The Third Avenue road is now engaged in equipping all existing horse and cable lines with electric traction, and for this purpose has just given out a contract for a power station which will eventually contain sixteen 3,000 kilowatt generators. The generators will be very similar to those described above, and are being built by the Westinghouse Company, who are the sole contractors for the whole work. The engines will be marine type, vertical, and are being built by the Westinghouse Machine Company. Sub-stations with rotary transferers will be used, as in the case of the Metropolitan system.

To give an idea of what may be done as regards power transmission, the following few figures may be useful. The first attempts at this class of work were made during the Frankfort Exhibition of 1891, 300 horse power being satisfactorily transmitted a distance of 106 miles with a pressure of 30,000 volts. Since that time electrical power transmission has largely increased, and the results obtained have been very satisfactory. 4,000 horse power at the present moment are regularly transmitted a distance of 85 miles to the city of Sacramento, California, at a pressure of 30,000 volts, where they are transformed into low pressure three-phase and continuous current for lighting, power, and traction purposes. At Telluride, Utah, 1,000 horse power are transmitted 55 miles at a pressure of 40,000 volts; 4,500 horse power are transmitted a distance of 40 miles to Salt Lake City at a pressure of 15,000 volts; 1,400 horse power are being transmitted 35 miles to Fresno, California, at a pressure of 11,000 volts; 2,000 horse power are being transmitted 30 miles to West Kootenay, British Columbia, at a pressure of 20,000 volts; 10,000 horse power are being transmitted from Niagara to Buffalo, a distance of 22 miles, at a pressure of 10,000 volts. All the plants are working and giving satisfaction, and have nothing experimental about them, and there are hundreds more such.

In the designing and carrying out of a large system, there are three points which are frequently overlooked and which may cause a disastrous failure. These are good and adequate bonding; thoroughly good insulation, both mechanically and electrically; and trucks suited for the work for which they are intended.

As regards the bonding, the bonds used should be flexible, but, at the same time, should contain no solder or brazed joint, and they should be expanded against the side of holes drilled in the web or foot of the rail, and held in place by pins. Bonds of this description, when properly applied, can be absolutely relied upon, the contact resistance of the bond with the rail not being greater than the resistance of the solid bond.

With regard to the third-rail insulators, very good results are obtained by using insulating bolts screwed into base plates which are fixed to the sleepers, cast iron chairs being fixed to the head of the bolts to hold the rails.

COMET-PHOTOGRAPHY.

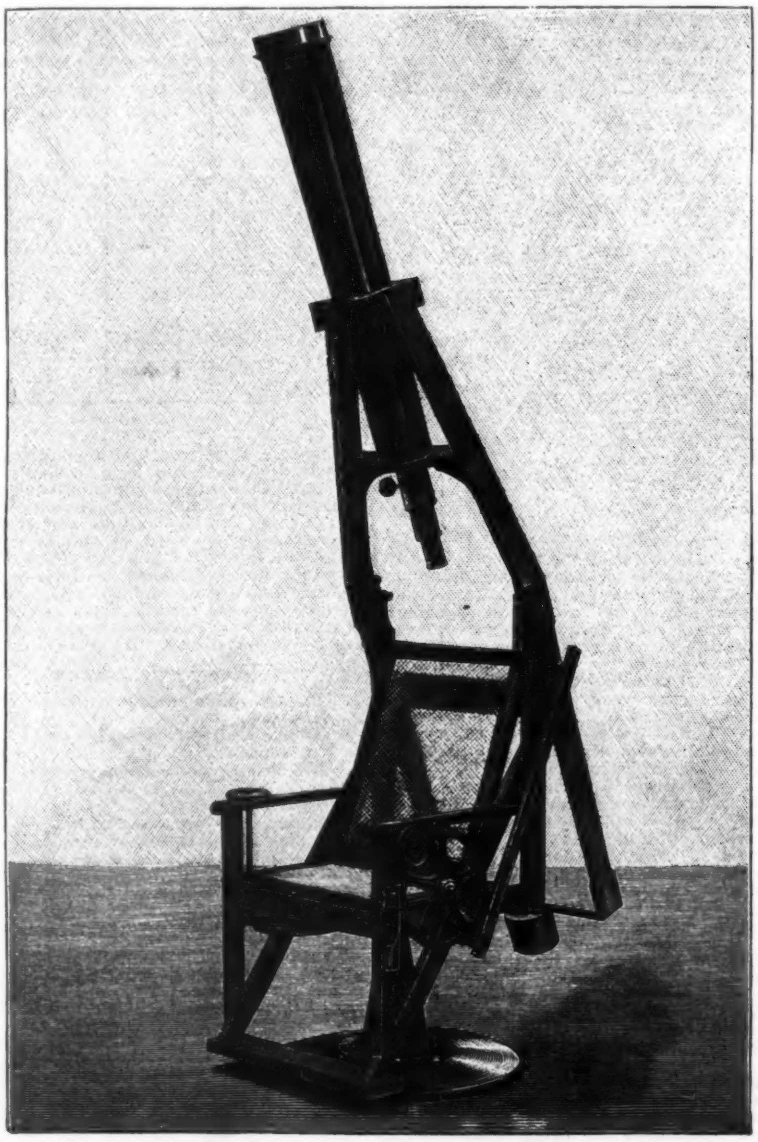
As a general rule a comet appears as a star whose luminous nucleus is surrounded by a more or less bright coma. Nucleus and coma together constitute the head of the comet. Besides the nebulous glare of light, the nucleus of the star is very often accompanied by a train which for various comets and even for one and the same comet varies in length, and which is known as a "tail." There are comets without a tail or luminous nucleus, which are seen merely as globular, nebulous masses. The coma is frequently weakly defined, for which reason the comet is hardly to be distinguished from the other stars. In many comets the tail is branched, and in others several tails may be observed.

The great majority of comets are not visible to the naked eye; and since they can only be seen with the most powerful instruments, they are termed "telescopic" comets. The orbits in which these comets revolve are ellipses, parabolas, or hyperbolas. Comets with elliptical orbits belong to our solar system and are termed "periodic." Comets, however, with parabolic or hyperbolic orbits are not members of our solar system, and are to be looked upon as wanderers from other systems. Such comets are visible to us at the perihelions of their orbits and soon after vanish in space. It can be inferred that many of these cosmic wanderers become members of our solar system after having deviated from their original paths, and that thenceforth they travel in closed orbits about the central luminary.

Comets with closed orbits are divided into three groups. To the first group belong those comets which have a period of revolution of three and a third to seven and one-half years; to the second group belong those comets having a period of revolution of sixty-nine to seventy-six years; and, finally, to the third group belong those comets whose periods of revolution number centuries and even millenniums. The elliptical orbits of comets are far more attenuated than those of the planets, and in many cases extend far beyond the path of Neptune. All orbital calculations made before the middle of the last century can be considered as untrustworthy; for the observations then made left much to be desired in the way of accuracy. The following are the most important comets discovered during the last century, with the periods of their revolution:

Comet.	Years.
1811 (I.)	3·065
1822 (III. Pons)	5·650
1825 (III. Pons)	4·386
1840 (II. Galle)	13·864
1846 (Hind)	10·818
1857 (III. Klinkerfues)	7·040
1858 (VI. Donati)	1·880
1858 (VIII. Tuttle)	6·000
1860 (III. Gronemann)	1·060
1864 (II. Tempel)	4·738
1873 (IV. Henry)	3·277

The appearance of comets, so far as their size is concerned, is as various as the period of revolution. The diameter of the nucleus can be as small as a hundred



THE COMET-SEEKER OF THE STRASBURG OBSERVATORY.

miles and as large as several thousand miles, these variations being often observed in the same comet. Great as are the variations in the nucleus, still greater are the variations to be observed in the coma. In Halley's comet the diameter of the coma, when observed in 1835, was seventy thousand miles, and in the comet of 1811, fully twenty-five thousand miles. The form and dimensions of the tail also vary to an extraordinary extent. In the comet of 1858, for example, the tail was eleven million miles long, in that of 1848 fully forty-five million miles. The width of the tail is smallest at the head and greatest at the opposite end and is, as a whole, far more constant than the length, which very often varies in exceedingly short intervals of time.

Owing to the elongated form of many comet orbits, exceedingly small perihelion distances are produced. For example, the comet of 1680 approached within thirty thousand miles of the sun, that of 1843 (I.) within nineteen thousand miles. The former in aphelion was distant from the sun seventeen thousand million miles and here passed through only three meters of its orbit in a second; while in perihelion it passed through fifty-three miles in the same time. Most of the observed comets, when in perihelion, are distant from the sun less than the diameter of the earth.

Telescopic observations of comets are best made by means of so-called comet-seekers. These instruments have powerful objectives, of short focal distance and large aperture, and are provided either with an azimuthal or parallactical mounting. The former is generally preferred, because the comet-seeker is mostly used as a portable instrument to be set up under the open sky. One of the most important conditions to be observed in the construction of comet-seekers is that the eye-piece end of the tube should be as short as possible, so that an observer in exploring a large region of the heavens shall not be required to change his position too frequently. In order to meet this requirement, many complicated constructions have been devised.

In the last few years celestial photography has also been applied to comets. Within this period no extraordinary phenomena have been observed, and no mention can, therefore, be made of any particularly prominent performances in this direction. Nevertheless, the photographs which have been obtained can be considered as highly successful attempts in comet-photography. On March 6, 1892, Swift, of Rochester, N. Y., discovered a comet which by the end of the month became so bright that it was visible with the naked eye. It was designated "Comet 1892 (I.)" and was photographed by Barnard at the Lick Observatory. On October 12 of the same year Barnard discovered another comet ("1892 V.") by photography. Of the comet ("1892 VI.") discovered by Brooks in the same year, on August 28, Archenhold, of Halensee, took three photographs, each of twenty minutes' exposure. Viewed through the comet-seeker, the tail of this comet was only one-half a degree long; upon the photographic plate it was five degrees long. Later this same comet was photographed by Liais, of Rome. At the Lick Observatory, Prof. W. J. Hussey has taken a whole series of photographs of Rordame's comet (1893 VI.) These interesting photographs were made by means of a portrait lens of six inches aperture and focal length of thirty-one inches. The plates used were 8 × 10 inches in size. Enlargements made from these negatives show a rather large nucleus surrounded by a coma one-quarter of a degree in diameter and almost globular in form.

The first successful photograph of a comet was made in 1881 by Dr. Draper, of New York city, who photographed Tebbut's comet ("1881 III.") An exposure of two hours and forty-two minutes produced a negative which showed the nucleus and ten degrees of the tail, as well as many smaller stars. Several days later, Draper photographed the spectrum of the comet after a similar attempt had been made by Huggins, on June 24, 1881. The photographs of the comet of 1882, the brightest and largest which had appeared since 1858 (Donati's comet), showed a noteworthy progress. The interest taken in these labors was small; for celestial photography at that time received but little attention.

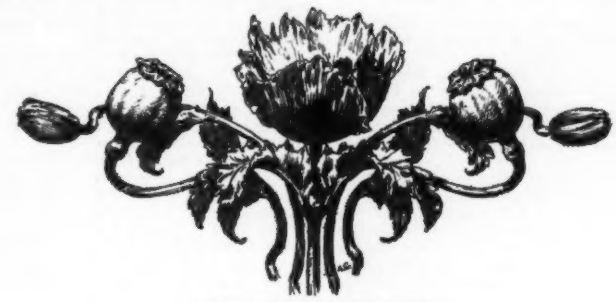
It has been demonstrated that many comets change

their form in exceedingly short periods of time—a phenomenon most readily observed in the larger bodies. Formerly sketches were made of these transformations; but as no two men will see the same object in exactly the same way, these sketches are of rather questionable accuracy. Photography has to a certain extent overcome this obstacle; moreover, the feeble light of small and weakly defined comets cannot be observed by the eye, but affects the sensitive emulsion of the photographic plate, provided the exposure be sufficiently long.

The layman in astronomy upon seeing a comet-photograph observes that the fixed stars, which of necessity are also seen upon the plate, appear in the form of longer or shorter lines. This is accounted for by the fact that the clock-train of the equatorial used in photographing must be timed to the comet and not to the stars. On account of the long exposure (two hours and over) during which the telescope keeps pace with the comet, the fixed stars apparently travel and are, therefore, photographed, not as disks but as lines, the length of which depends upon the time of exposure.—Stein der Weisen.

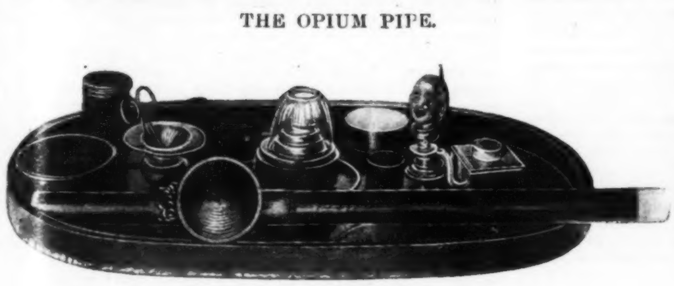
THE ASIATIC POPPY, THE DEADLY FLOWER OF THE YELLOW RACES.

LARGE and sumptuous, the flower of the poppy seems made only for its fine appearance. It contains, nevertheless, a deadly poison—opium. After once using opium a person quickly becomes a slave to this tyrannical habit. Entire races are disappearing, victims of this flower, which kills the body with terrible suffering after having destroyed every moral sentiment, every spark of intelligence, and all will power. The peril is great in the countries of the extreme East, and, according to "Lectures pour Touts," is much to be feared in the French colonies of Tonkin and Indo-China, where the people should be protected against this most deadly enemy.

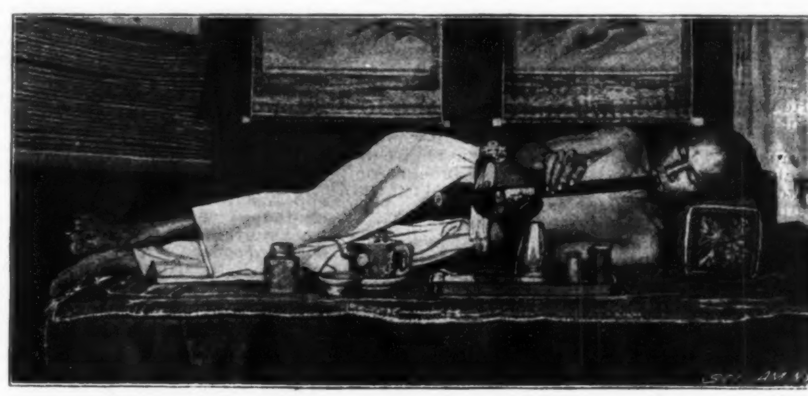


THE POPPY FLOWER.

THE OPIUM PIPE.



AN OPIUM SMOKER'S OUTFIT.

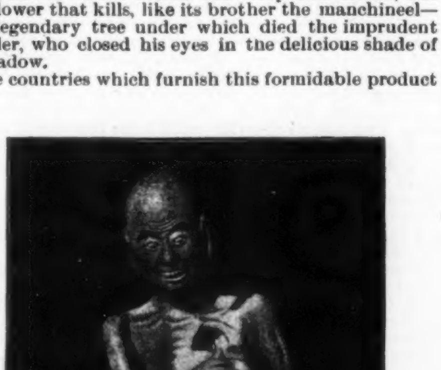


OPIUM SMOKER LIGHTING HIS PIPE.

Man is endowed by nature with admirable resources of energy and endurance. But it seems that he goes to work to destroy them. Provoked then at his loss, he invents scourges more deadly in their continued operation than the plague or the most frightful epidemics have ever been. They slip in under the guise of a pleasure which is not in the law of nature, or which forces the limits of it. Such is alcohol, such also is opium.

Opium is the juice of a plant having large, heavy flowers and light-green leaves—a plant which every one knows and which is called the poppy. "Fatal" plant, flower which makes one sleep and dream, but also flower that kills, like its brother the manchineel—that legendary tree under which died the imprudent traveler, who closed his eyes in the delicious shade of its shadow.

The countries which furnish this formidable product are chiefly Asia Minor, Persia, and India. The opium is taken from the fruit of the poppy by making an incision into it when it is ripe. The next day the sirupy liquor which has flowed out is collected, and this, after fermenting in the air, becomes the terrible poison. Benares, Patna, and Malona are the three great Hindoo centers from which sixteen or eighteen hundred cases of opium are exported monthly to the great commercial advantage of the English.



EFFECT OF THE OPIUM HABIT UPON A CHINESE DEVOTEE.

Opium is used in three ways. First it can be drunk in the form of laudanum, which is directly derived from it. Drop by drop people begin to take it, measuring out the dangerous liquid with very great care, by means of a medicine dropper; for if a person can, by increasing gradually, finally take a great quantity of it (8,000 drops per day), the greatest prudence is necessary when he first gives himself up to this vice. Opium can also be taken in the form of small pills, and finally, as is most often the case, be smoked.

The opium pipe is composed of a stem about twenty inches long, made of woods differing in value, and more or less artistically carved and decorated with jade, lacquer, wood, or metal. This stem has a small cup, which connects with a hole in the stem and forms the bowl of the pipe.

Opium in the solid state is moistened and prepared beforehand in small balls the size of a pea and weighing from one-quarter to one-half an ounce. One of these is picked up with a needle and held near the flame of a small lamp. When it begins to shrivel it is dropped into the bowl of the pipe and the bowl is closed. The opium is then lighted by holding the bowl near a small lamp. The smoke is slowly inhaled and held in the throat till the next breath is taken. One pipeful lasts but a few minutes, and another succeeds it until somnolence seizes the smoker and his hands let go the pipe. All intelligence disappears from his eyes, his spirit soars into space, and his body becomes in reality a senseless rag, fit only to roll in the corner.

Opium is smoked in China especially. The Emperor has splendidly equipped smoking apartments, and the wealthy all have set apart in their houses a silent, solitary room, where they can have "smokers" with their friends.

The decoration of these rooms is often marvelously luxurious. A large bed made of lacquered wood, inset with mother-of-pearl, and covered with carvings of foliage, ornamental flowers, and gilded dragons, is set around the walls of the apartment, and occupies three-fourths of the space. A light mosquito netting, supported by several columns, covers the bed, while on it several mats are placed end to end, one mat being intended for each smoker. The walls are hung with rich silken stuffs, fantastically embroidered.

There are also public smoking rooms for those who cannot afford, or whom circumstances prevent, having private ones. These are fitted up to suit all classes, as are our cafés and saloons. The best have all the luxuries of the private rooms, and are used by well-to do people. The European naval officers who are temporarily staying in China are often among their habitués. The others are dens infected with a repulsive odor and full of noxious smoke.

Paris, too, has merchants who sell smuggled opium, and it contains a few smoking rooms also, which are carefully kept secret, for they are maintained against the law. What does not one find in Paris? A person must be conducted by one of the initiated in order to enter any of these apartments. You knock at a particular door on one of the floors of a certain building and you find a neat, copper-colored Chinaman, dressed in his national costume, with long, black queue and gracious smile. Upon seeing your companion, he allows you to enter his modest apartment.

As soon as you enter you are sensible of an odor *sui generis*, which does not exactly resemble that of tea, or tobacco, or laudanum, but seems to be made up of a mixture of all three with a faint burnt smell added.

If you feel in the mood for it, stretch yourself out at your ease, while the yellow man, all the while smiling, fills a pipe for you with his slim fingers, and brings it to you. What is the result if you smoke this pipe followed by three or four others? A violent headache, an intense burning in the throat, and a desire to vomit. Several cups of tea will then be served you very opportunely. But you do not see in the least pleasant visions glide before you.

The clients of the Chinaman are quite numerous. Many who smoke opium at home come to buy it of him, for opium is a product difficult to obtain in France without a physician's order. The exposition

AN OPIUM SMOKER'S APARTMENT.

of 1889 brought him a fortune, for it is said he made $20,000, which he afterward lost in unlucky speculation. He smokes now to console himself, and he has smoked so much that he is rapidly nearing Death's door. A short time ago the police threatened him with imprisonment. He became so melancholy that he gave way to almost incessant smoking, and as a result he is now nothing but a skeleton covered with parchment.

Let us now see what some of the terrible effects of opium are upon its victims, whom it does not release from its grip this side of the tomb.

The Englishman De Quincey, who at the beginning of this century wrote the "Confessions of an Opium Eater," gives us at length his personal impressions. He took opium first as a remedy for severe indigestion. It relieved the pain and caused him to experience strange and pleasant sensations. His spirit took wings. He saw in visions his past life, the images of dear friends whom he had lost and of heroes he admired.

"But, little by little," says Arvède Barine, in the chapter about him in her interesting volume on the neurotics, "his stomach grew worse, while his system craved increasing doses of the poison. At this point his sleep became peopled with phantoms—interminable grinning processions. All became hideous specters; he had the perpetual impression of descending endlessly into black gulfs and of eternal stairs, such as one often experiences for a moment in dreams. He saw immense oceans tossing aloft on their waves human figures, and also desperate and furious faces which came howling out of space.

"A heavy veil was spread over his intelligence. All work, all effort at attention, was impossible in his brain. It was almost imbecility; he saw plainly what he ought and ought not to do, but this had no influence whatever upon his conduct. His conscience became doubly acute and tried to govern his actions, but his will was gone entirely. What a terrible punishment was this! All happiness fled from him, and there was nothing but misery in his house. He saw his wife and children suffer and weep, but he was a paralytic who could do nothing. Driven to suicide, he made an attempt.

"He knew then the extent of his misfortune and the weight of the chains that bound him. Opium is a pitiless tyrant, unrelenting in causing to suffer all who try to escape him. He tried many times in vain to give up the habit by degrees, but these attempts brought on such tortures that he soon relapsed again and felt the yoke of the 'black idol' weighing him down. This lasted several years."

Such are the cerebral troubles produced by opium. With De Quincey, whose mind was never in perfect equilibrium, we have what might be called an acute example. The effect is different with people of a quieter nervous system. Such people are generally reduced to a state of passive idiocy or to brutishness pure and simple. This is the case with ten or twelve millions of Orientals who smoke opium.

The reader must not think for a moment that all these Chinese and Annamites who adore the "black idol" have ever asked of it gilded dreams and other pleasures of the mind unknown to common humanity. A purely bestial need which they have habitually acquired from infancy onward by means of imitation constrains them and commands them to smoke when the accustomed hour arrives. If they delay an instant beyond the accustomed time, they are seized with terrible pains. It is necessary, therefore, for them to smoke.

At length their existence becomes reduced to simply smoking one series of pipes after another. Then the flesh of these wretched persons dries up and becomes mummified, the skin clings to their bones, the eyes start out from their sockets, a stupid grin of happiness contracts their features, and there is nowhere a more hideous spectacle of human degradation. The Chinese statuette we reproduce herewith shows very realistically the terrible ravages made by opium.

The place to see these victims of the opium habit is in the popular smoking rooms and low establishments which they frequent. The interior of one of these dens consists of a series of long rooms clouded with a thick, acrid smoke and filled with fetid heat. Nothing can be distinguished at first, but soon the visitor perceives through this dismal haze tables placed here and there with cups of tea scattered about upon them, while on the floor are rows of pallets upon which are stretched what were once human beings. Beside each one of these figures is a small cocoa-oil lamp at which it occasionally lights a pipe it is smoking. M. Roger de Beauvoir, in his "Journey Around the World," describes the scene as follows: "Look," says he, "at these dying bodies, these trembling arms trying to relight a half extinguished pipe from a dying flame, these shriveled fingers which cling to the mats on which they are stretched out, these yellow eyes, this sudden sweat which trickles down their sides over the projecting ribs, these stupefied heads from whose parched throats emits a last venomous puff." This is the sad yet real truth regarding the joys of opium.

The use of opium is causing the decline of China. It was only as late as the last century that the taste for opium developed and that the Portuguese introduced the commerce in it. In 1773 the East Indies Company began sending out profitable expeditions, for England had immediately seen it to be "a good thing." By 1800 she was already sending out four thousand 158-pound cases each year. The cost price was only $25 per case, and she sold them for $640. From that time China used opium as we use tobacco and alcohol. Its success was formidable in this country of misery, where the people know only suffering, privation, and oppression.

The Chinese government saw the evil, and tried to put a stop to it by prohibiting the sale of opium. Then England began smuggling it in. It was necessary to take strong measures, and the Imperial Commissioner Lin was charged with executing them. He arrested the European traders in the factories at Canton, together with Capt. Elliot, the superintendent of English commerce, and thus got possession of twenty thousand cases of opium, which he threw into the sea on June 7, 1839. It was a kind of Chinese "Boston Tea Party."

The anger of the English was great. They declared against China the odious war known as the "Opium War." On July 20, 1842, their fleet of sixty-five vessels appeared off the Isle of Gold, before the celebrated city of Chin-Kiang-Fow. When the Tartars who defended it saw they were losing, they rushed into their houses, and, after killing their wives and children, returned to fight the enemy to the death. Those who were not slaughtered by the English cut their own throats. The result of these operations was the treaty of Nankin, that is to say, liberty for England to intoxicate all of the race who hindered her, and thus to destroy it more surely than by arms, while she makes a fortune at the same time.

Since then the importation of opium into China by the English has increased considerably. In 1872 it reached fifty-two thousand cases. It is only a little more than that to-day, owing to China's now manufacturing her own poison, which is of an inferior quality and much more deadly.

The opium habit is exceedingly rare among us, but we have its near relative, the morphine habit. This vice, though happily much less prevalent, is, however, not less tyrannical and deadly.

The peril is great especially in our colonies of Tonkin and Cochin-China, where several million rupees worth of opium is consumed. The near-by example of China ought to warn us, and we should try to check the gangrene if there is yet time.

For to-day more than ever before is that race unfortunate who, in the great battle of modern life, lowers its forces in stupid and degrading vices. The opium habit is one from which there is no escape. The terrible warning of Dante may well be applied to it, "All hope abandon ye who enter here."

THE INTELLIGENCE OF TROPICAL ANTS.*

By DR. EUGENE MURRAY-AARON.

DURING my first visit to the West Indies in 1880 nothing entomological so impressed me as the superabundance of ant life, both in species and in individuals, and the unrivaled opportunities there afforded for the pursuit of studies into the degrees of intelligence exhibited by these creatures, undoubtedly the highest development of the articulate type. From the first I was impressed, as I had already been by the literature of the subject, with the fact that just as the butterflies of the tropics were more beautiful, just as the beetles were larger and more powerful, just as the odonats were stronger of wing, the stridulating orthoptera more overwhelmingly sonorous, and just as each of the orders appeared to reach the most pronounced type of its kind upon nearing the equator, so the ants of the tropics exhibited to a greater degree than did their northern congeners those wonderful attributes of mind for which they have been famous since the days of Huber.

More or less close study of these creatures in their own homes, some of it in Jamaica and Haiti, of the most painstaking nature, and some further studies made upon ants brought north with me from Hayti, have but confirmed and strengthened my high estimate of their intelligence.

Familiar with the many experiments which the fertile ingenuity of Sir John Lubbock has placed before us, acquainted with the writings of Huber, Ellendorf, Lincecum, Belt, Bates, and our own McCook, I have profited by their labors and suggestions in following many lines of experimentation in somewhat different directions from theirs. It is from notes of very many observations that the following accounts are derived. While the limits of this paper preclude the possibility of any connected attempt to point out the bearing of these testimonies upon the great evolutionary scheme of nature, it may, at least, serve to point out how rich a field awaits the painstaking resident student in the tropics.

Having in mind the experiments of Lubbock wherein he showed the strong likes and dislikes of many ants for certain colors, and in which he discovered that, in a colony of nearly 2,000 ants brought under the influence of four principal colors, 890—or nearly one-half—were found congregated beneath the slip of red glass, 544 under the green, 495 under the yellow, and only 5 under the violet, I planned a series of experiments on one of the tree-inhabiting species common in the lowlands of Jamaica. This species builds an oblong globular hornet-like nest, about one foot in diameter, sufficiently high in trees or shrubs to be safe from the occasional inundations of the rainy season. Into the side of one of these I carefully cut a round hole about two and one-half inches in diameter, and over this I pasted a piece of thick black cloth. This work was, of course, done at night; he would needs be a hardy or pachydermatous student who would undertake as much by day. The next morning, after carefully and quickly removing the cloth cover, I allowed the sunlight to pour into the nest, to the very evident discomfiture of its inhabitants. Yet, much as the interior workers or builders of this species dislike the light, they continued to engage in frantic efforts to bring the building pulp from the inner chambers of their nest in their attempts to patch up the hole. This work they continued, and in far greater numbers when I placed a red screen between them and the light, but their numbers decreased under a green or a pale orange light to about the same as under the pure sunlight; and with a screen of a bluish-purple color I was able to drive every one of them back from the hole into the inner recesses of the nest. It was evident that these were like minded with the species of the genus Lasius experimented upon by Lubbock, and that the colors acted upon them in a graduated series, which exactly corresponds with the order of color influence on a photographic plate.

Several other like experiments resulted in apparent proof that this color sensibility was common to all species of the ant tribe; but when I came to experimentation on their susceptibility to sound waves my results were widely dissimilar to those obained by Lubbock.

Sir John reports that, after many experiments, he has failed to find that such sounds as those produced with tuning forks, violins, shouting, whistling, etc., produced even the slightest influence on various species of the genera Lasius and Formica. He also was unable to obtain any evidence, by the use of sensitive flames, the telephone, or the microphone, that his ants emitted sounds inaudible to human ears. One of my first experiments was made with the tree-inhabiting species, already referred to, and consisted simply in whistling and tooting on a crude bamboo fife close to very many of their nests. The results were identical in every case, with one exception; and, as a few blows on that nest resulted in nothing, I came to the conclusion that it had been abandoned. In every case very high or shrill notes brought many of the occupants of the nest to its mouth, not apparently in alarm, rather from curiosity; but deep or bass notes invariably resulted in driving them back. For example, on whistling the first four bars of "Die Wacht am Rhein" in as high a key as possible I immediately collected a wondering, but apparently appreciative audience of several hundred ants; when, however, I dropped an octave or more and whistled the deeper notes of the refrain, I drove my audience indoors in short order. These results led me to try another experiment, that of first attracting an audience with a bamboo fife and then treating them to a thunderous serenade on the negro's most beloved musical instrument, the tom-tom. The haste with which they tumbled over each other in the effort to seek security within showed evident fear. Very naturally, this led to yet another experiment. At the beginning of several tropical thunder showers I brought out the members of various colonies of this species, but invariably at the first following thunder-clap the retreat produced by the tom-tom was repeated. Much the same result was produced on several of the earth-inhabiting ants. I have finally arrived at the conclusion that the thunder and the almost equally deafening roar of a tropical downpour are at the bottom of the ant's dread of sounds approaching the bass octaves; while curiosity is the basis of their appearance in answer to the higher notes, combined, perhaps, with their acquaintance with the shrill and high notes made by stridulating insects during all periods of calm weather.

The early experiments of Huber, afterward confirmed by Lubbock and others, to the effect that it is the sense of smell which is most acute in ants and whereby they track one another, is well known. Huber, having obliterated the scent along one of their trails by drawing his thumb across it, observed that ants arriving at that point became confused and wandered about aimlessly until discouraged or until the trail on the other side of the obliterated space was run upon by chance. Lubbock's more systematic experiments have proved beyond dispute that ants are guided by odor, and not by sight; that they are confused by losing the scent of their predecessors, and not by missing their footprints or other visible signs. The fondness of ants for an over-ripe pineapple is one of their prominent characteristics. Taking the juice of a rotting pineapple on a camel's hair brush, I ran it around in varying curves and sweeps on the galvanized roof of a manor-house porch, on which no ants could be seen at the time. That I might be able to identify the track made, I at the same time drew a pencil mark along the middle, but to satisfy myself that it was not the lead pencil mark that any formican pathfinder might follow, I drew frequent offshoots or bypaths with the pencil. An hour or two of tropical sunlight removed all visible signs of the pineapple juice, at least to my eyes, as it did also to my sense of smell. Not so to the ants, which, one after the other, I placed at the edge of the roof where the pineapple trail started. Each of these at a rapid gait and with unfailing accuracy followed the track until a piece of pineapple, the well earned prize, was gained at the end. In reaching this prize by a very circuitous route they passed very near it several times but, although its odor must have been perceptible from these points, they invariably kept along the intended highway. In not a single instance was one of the false tracks of the lead pencil followed, nor could I detect the most momentary faltering at any such meeting of two ways. At one place, however, where I later painted a fork in the road, the latest, and, presumably, most odorous path was taken, although it was much the longest way to the goal. When with a sponge dipped in hot water I washed away about eight or ten inches of the trail and drove the next ant off in an entirely wrong direction, each of its followers took the same wrong track, although the piece of pineapple was near at hand in just the other direction. When, however, I drove another ant directly to the prize from this break in the trail, and, after it had been allowed to partake of the coveted sweets, drove it back over about the same route, there was no hesitancy on the part of any future visitor to follow the path thus marked out. Clearly it was the power of scent, scent at close range, not that at any distance, which resulted in these exhibitions of the pathfinding power.

Four months having been the extent of my residence at any given locality in the tropics, I have not been able to make the extended tests as to the length of memory of ants that have been made by some others. Belt tells us that, while resident in Nicaragua, he was instrumental in driving a colony of leaf-cutting ants from their nest by pouring dilute carbolic acid into it, and they took up their abode in a newly constructed home about two hundred yards away. A year after this he had reason to drive them from this nest, and, greatly to his surprise, they immediately betook themselves to the former domicile, which in the meantime had been utterly deserted, and, apparently, unvisited. Karl Vogt, in his "Thierstaaten," narrates the achievement of a colony of Formica fusca which used to go through inhabited streets to a chemist's shop 600 meters distant, in order to obtain access to a vessel filled with sirup. As this was repeated from year to year, each early summer seeing the long column, broken by the cold of the autumn before, reorganized and active, it is fair to conclude that the ants remembered the existence and whereabouts of this sirup store from year to year.

A colony of Formica omnivora at the Baths of St. Thomas, Ja., divided by me in early July and widely separated, had part of each new colony taken over to the other on my visit to that place in late October, nearly four months later. Although omnivora is a most savage and warlike little creature, attacking and killing every stranger that ventures within or even to the orifice of its nest, in every case the ants thus brought back were recognized as relatives or former comrades, although indiv.duals of the same species

* Read by request at the annual meeting of the Brooklyn Entomological Society.

from other nests were instantly set upon and torn asunder. Much more remarkable than this was a case studied and vouched for to me by the Hon. William Bancroft Espeut, by whose recent death her British Majesty's colonial government and the study of tropical botany both lose a valued adherent Mr. Espeut had his winter home on the north coast of Jamaica and his summer residence high in the Blue Mountains, overlooking the Liguanea Plain, back of Kingston; the two were about twenty miles apart by the road. Specimens of the genus Echiton, the foraging or army ants, were taken from the lowland to the mountain residence, and after three years some of them returned to their fellows, were instantly recognized and welcomed home, if antennal caressing and like signs of good fellowship are to be thus interpreted. Now there is no species of the Formicidæ that is more savage in its treatment of intruders than are the species of the genus Echiton. However, it is not entirely safe to attribute this power to memory in its exact sense, as is shown by an experiment made by Lubbock. As described in Romanes' "Animal Intelligence," Sir John "separated some ants from a nest while still in the condition of pupæ, and, when they emerged from that state as perfect insects, transferred them back to the nest from which they had been taken as pupæ. Of course in this case the ants in the nest could never have seen those which had been removed, for a larval ant is as unlike the mature insect as a grub is unlike a beetle; neither can it be supposed larva, hatched out away from the nest, should retain when a perfect insect any smell belonging to its parent nest—more especially as it had been hatched out by ants in another nest; nor, lastly, is it reasonable to imagine that the animal, while still a larval grub, can have been taught any gesture signal used as a password by the matured animals. Yet, although all these possible hypotheses seem to be thus fully excluded by the conditions of the experiment, the result showed unequivocally that the ants recognized their transformed larvæ as native-born members of the community." Parallel to this and somewhat supplementary to it is my own experience with individuals of Formica omnivora, and two of its congeners, both as yet unidentified, which I brought away from Haiti on my last visit to that island. Omnivora and one of the other two species were transferred in both the mature and the larval stages, the other only in the pupal stage. Some of the immature forms of all three were intrusted to each of the adult colonies to rear, for, as Romanes observes, "it is to be noted that, although ants will attack strange ants introduced from other nests, they will carefully attend strange larvæ similarly introduced." After all had attained the mature state I thoroughly satisfied myself by repeated and various experiments that each recognized its own blood relationships, while quick to resent the intrusion of any others. The mystification displayed, and the very evident signs of conflicting disposition on the part of the younger adults, who, having been recognized by their older relatives, and having recognized them in turn, saw the young adults of another species, with which they had been reared in perfect harmony, torn limb from limb by these same relatives, formed one of the strangest sights I ever witnessed in the entomological world.

The feeling of fellowship and sympathy varies in intensity very greatly in various species of ants; and not only through the difference in species can we trace this, but even in individuals of the same colony, under entirely like conditions, are very different degrees of sympathy to be observed. Belt tells us that he found the army ant, Echiton humata, always ready to aid a distressed fellow from its own colony. Specimens that he plastered to the ground with clay pellets, the head or only the antennæ being left in sight, were always rescued as soon as the first good Samaritan on the scene could return with sufficient reinforcements. Yet I found that while in some colonies of Echiton this was the almost invariable rule, the adjoining colony, perhaps, would be mostly composed of individuals utterly indifferent to the claims of a fellow in distress. My favorite experiment was to tie an ant near its home, fastening it by some of the finest jeweler's wire to a nail firmly driven into the ground, passing the wire around at the juncture of the thorax and abdomen. Various were the means used to free the prisoners under these circumstances, from the laborious and futile one of digging around the nail to the heroic but rather drastic method of pulling the victim in two and thus, at least, removing him from the bondage of the wire.

McCook has pointed out the fact that it is to the ants that we will have to turn if we seek the pioneers in massage, the Swedish movements, manicuring, and the kindred cleansing arts. He narrates most entertainingly his having been a spectator on several occasions when an ant was washing and making a toilet for a fellow ant. The care that they take of the immature individuals in a colony is as wonderful as it is necessary to the life of the growing youth. From the time when, by constant licking, the egg is made to increase very materially in size, and when by regurgitation the very young are fed by the workers, mouth to mouth, down to the last moment when the just emerged adult is gently aided in divesting himself of that close fitting, brown "undershirt" in which he is born and which makes freedom of movement impossible, all through the immature stages, the attention lavished on the youths of the colony is quite equal to that showered by a fond human mother on her children, and far in excess of that accorded to the wretched children of our slums. But it must be remembered that ants have progressed in their civilization far beyond the point where slums, and faulty drainage, unswept streets and unventilated rooms, would be tolerated. I seriously doubt whether in all ant-dom sufficient that is scandalous or socially suicidal could be found to keep a Formican Lexow Committee busy for one day.

Some pupæ that I was transporting when unpacked were found to be tipped, here and there, with minute tufts of some species of mildew, which was growing, not on the pupæ themselves, but on particles of decayed wood adhering to them. Knowing that they required immediate and most careful attention, I at once gave them to some adult ants, which, though of another species, quickly set about to remove the growth and all the foreign matter They were prompt to avail themselves of a small tin of water that I placed near at hand, and it would have been a lesson in painstaking cleanliness, excellent for most nurses in our orphan asylums, to have observed with what thoroughness each of these pupæ was bathed and rebathed and then deposited in a sunny spot to dry. The bathers, having deposited their charges suitably, quickly returned with another ward to the water's edge, leaving the washed pupæ to the care of other workers who moved around on all sides waving their antennæ at the most rapid rate, but not touching the pupæ with them. It appeared to me that this must have a fanning, and, consequently, a drying or evaporating effect, and I have no doubt that was its purpose.

I should much like to tell of the games and sports that it has been my good fortune to witness Some of these have been well described by Huber and Forel, as well as by Bates and McCook; they are so marvelous and almost incredible as to need to be seen before they can be believed or understood. Our recording secretary,* a most ardent upholder of the claims of football, in the great scheme of the survival of the fittest, would, I know, be pleased to know how hazardously near to breaking all Rugby rules the little creatures occasionally come in an exciting contest.

So, too, for our corresponding secretary's† sake, I should like to describe the classes and complex courses of study or training that the youth of some colonies must needs be put through to fit them for the duties of the adult life. But time affords only the opportunity now to allude to another one, and the most interesting I think it to be, of the family characteristics of ants.

Naturally, being primarily a student of the diurnal Lepidoptera, I felt the most interest in the cow-herding habits of ants, because, in the tropics especially, the larvæ of certain species of the Lycænidæ are the commonest members of these droves of cattle. McCook has alluded to finding immature scale insects, aphides, and Lycænid larvæ all in the same herd of "ant cows." I have found herded within one nest two species of aphides, a scale insect, and the larvæ of Lycæna marina and Lycæna Pseudofea. Each variety of cow was left carefully by itself in a separate compartment, exactly as in the cases reported by McCook.

This ant habit was made even more interesting to me by the theories of Darwin and Romanes, which I quote. Says Romanes: "The facts show that the yielding of the secretion to the ants is, as it were, a voluntary act on the part of the aphides, or, perhaps more correctly, that the instinct to yield it has been developed in such a relation to the requirements of the ants, that the peculiar stimulation supplied by the antennæ of the latter is necessary to start the act of secretion; for in the absence of this particular stimulation the aphides will never excrete until compelled to do so by the superabundance of the accumulating secretion. The question, therefore, directly arises how, on evolutionary principles, such a class of facts is to be met; for it is certainly difficult to understand the manner in which this instinct, so beneficial to the ants, can have arisen in the aphides, to which it does not appear, at first sight, to offer any advantages."

Commenting on this problem, Mr. Darwin says: "Although there is no evidence that any animal performs an action for the exclusive good of another species, yet each tries to take advantage of the instincts of others;" and "as the secretion is extremely viscid, it is no doubt a convenience to the aphides to have it removed; therefore, probably they do not excrete solely for the good of the ants."

Only the fact that these students were theorizing on the discoveries of others, without any close acquaintance with the habits of these pastoral ants and their "cows," accounts for such glaring misapprehensions of the true *motif* of this whole wonderful interrelation of such widely dissimilar animals as we here find associated. Had either of these gentlemen taken a lady-bug or any of the predatory beetles or Hemipters and quietly dropped it upon a leaf where some "ant cows" were feeding and being herded by ants, he would have gone far to open his eyes to the true explanation of this problem. Before one of the luscious "cows" could have been seized upon and bitten into by the beetle or bug a dozen ants would have been upon him and he would indeed have been a quick-witted member of his race if he could have taken to wing ere they had maimed him beyond repair or even torn him apart. Then, had either of these gentlemen taken a newly emerged ant and placed it upon a leaf where "cows" were feeding, but from which all the herdsmen had been carefully removed, and watched its examination of the "cow," with, perchance, a nip or two at the defenseless creature, and also noted how quickly the secretion was exuded by the "cow," he would have had yet other proof that the aphid is quite as much the gainer by the partnership as is the ant. If, furthermore, he could have watched, as have I along the shores of Laguma Enriquillo, in Santo Domingo, the ants in very considerable numbers carrying the larvæ of Lycæna exilis away from low-growing plants of the genus Cassia, which would soon after be entirely inundated by the rains, which even then had set in, he would not deem it more wonderful that these "cows" had learned to know and respond to their care takers than that the latter had divined that an approaching rainy season meant the drowning of their "cows" and a consequent dearth in the milk supply.

To me it seems quite as understandable just how the first aphides or other "cows" came to give off their secretions through pain in being bitten by predatory ants, which, in turn, learned that a live aphid represented a continuous food supply while a dead one was a meager meal at most, as it is to understand how primitive man, far the inferior of the ants in general intelligence, came to induce cattle, sheep, goats, dogs, horses, and other of our domestic animals to yield to his early and barbarous rule.

Before closing I wish to state most emphatically that Sir John Lubbock is far off the mark when he states that ants, "with all their wealth of instinctive endowments, are utterly destitute of intelligent resources." It is a pity that on a comparatively few experiments on one species of ant, Lassius flavus, he should have based so sweeping a conclusion simply because that species afforded him no individuals capable of sufficient resourcefulness to push a straw or paper bridge back into place, that otherwise inaccessible sweets might be reached. The observations of three naturalists, resident in the tropics, Ellendorf, Belt, and Kreplin, amply controvert this hasty conclusion. Ellendorf saw his ants push back into place a floating straw which they had been using as a bridge to get at food placed in the center of a dish of water, after he had pushed the bridge out of place. Belt had the pleasure of witnessing the bridge-building skill on the part of Echitons in Nicaragua. And Kreplin has described the water-crossing art of Echitons on a small tributary of the Tocantins in Brazil so graphically that I cannot do better than quote his words:

"If no natural bridge be available for the passage, they travel along the bank of the river until they arrive at a flat sandy shore. Each ant now seizes a bit of dry wood, pulls it into the water and mounts thereupon. The hinder rows push the front ones even further out, holding on to the wood with their feet and to their comrades with their jaws. In a short time the water is covered with ants, and when the raft has grown too large to be held together by the small creatures' strength, a part breaks itself off and begins the journey across, while the ants left on the bank busily work at enlarging the ferryboat again." To this description I wish to add what has already been pointed out by a writer in The New York Sun, who observed it in the United States of Colombia, and what I also saw on two different occasions, once on a small creek near Puerto Limon, Costa Rica, and again near Cape Haitien, Haiti. In every instance these rafts were pointed up stream along the bank until they were sufficiently long to let the upper end drift out and by the force of the current be carried across to the opposite bank, when that end became the hinged one, and the first point, being released again by the water's force, was carried across, and thus all were safely over.

Sir John Lubbock needs but spend a half year in the tropics, needs but see one of the irresistible hordes of the warrior ants carrying everything before it yet under perfect control from the head of the column, needs but see the serpent-like columns of the umbrella ants, a half foot wide and perhaps a half mile long, and needs but try, in either case, to thwart or divert these tiny creatures from their set purpose, to find that he was grievously wide of the mark when he conceived this to be a family of insects "utterly destitute of intelligent resources."

* Rev. Dr. Geo. H. Hulst, the microlepidopterist.

† Archibald H. Weeks, Esq

SOME DATA ON RATTLESNAKES.

To the Editor of the SCIENTIFIC AMERICAN.

In the SCIENTIFIC AMERICAN for November 19, 1898, there is an interesting article on our common snakes read by H. C. Holmes before the Philadelphia Natural History Society. I will now take the liberty of submitting some additional data, and there is one point in particular which is not mentioned in the paper referred to. This is the question of whether our rattlesnakes are oviparous or viviparous. From close observations made in our Zoological Garden and Museum of Natural History at San Pedro Springs, some time ago, it is apparent that the latter is the case. I can corroborate the statement made in the Holmes article concerning the care of the rattlesnake's young ones in times of threatening danger. A few years ago a friend told me that, on opening his pasture gate, he noticed a large number of small rattlesnakes near the fence. On threatening to kill them with a stick, they all of a sudden disappeared, and, on searching along the fence, he noticed an old rattlesnake, which, after he killed it, discharged from its mouth and throat a number of very young snakes, which rapidly crawled away under the fence. Similar observations are undoubtedly on record as stated by Mr. Holmes, and I can vouch for the correctness of the above case.

Concerning the question whether the crotalus species are oviparous, I give the following statement of an eye witness who is connected with our Zoological Gardens and Museum as custodian, and who is a man of no mean scientific ability. He says:

"I noticed that one of these females was pregnant. Two-fifths of its body was gaining in thickness toward the end part. According to the reports of several scientists of natural history, this snake must have been impregnated during its free state in the prairie, although it seems to me doubtful that the pregnancy among snakes should last such a length of time. On September 2 I found the snake lying in an abnormal position in the middle yard of the cage; the back part of its body lay slightly curved on the ground with its tail lifted up, having born two young snakes, enveloped in a slimy, transparent membrane. I have watched the entire process, and in a short while ten young snakes more were born at intervals of from four to ten minutes. The snake showed no signs of excitement, and after the birth of the twelve snakes she slowly left to unite with the other ones. These young snakes lay alone on the bare ground in a slimy mass, and after two hours the firstborn made a movement, the slimy envelopment disappeared and the snake stretched itself to its entire length, measuring one foot. It was of gray color, with many whitish ringlets and heart-shaped head. It did not creep to its mother, but laid itself in a spiral position in the corner of the cage, with its head elevated and the tail in the middle of the spiral formed body. I tried to anoy it with a piece of wire, in order to ascertain if it showed signs of biting, but it was perfectly innocent. On the second day, early in the morning, I found all twelve young ones wound up in one bundle; the mother did not care anything for them, and vice versa."

In connection with the above report it may be noted that there are other species of amphibia which are viviparous, and particularly one of our smallest known fishes, the minnow. R. MENGER, M.D.

San Antonio, Texas.

There was recently completed near Boise City, Idaho, a siphon pipe 48 inches in diameter, and 1,700 feet long, with a maximum depression of 350 feet, says The Railway Review. This pipe supplies the water for hydraulic purposes to eight mines. The pipe is carried over the Boise River on a trussed bridge. It is made of riveted steel plates, in sections, and is provided with expansion joints, the object of which was to prevent the opening of the joints by change of temperature while the pipe was being laid.

MALARIAL DISEASE IN TROPICAL COUNTRIES.

ON June 10, 1898, Prof. Dr. Robert Koch, the eminent bacteriologist, delivered at Berlin before a large audience, which included many eminent persons specially interested in the colonial policy of Germany, an important and highly interesting address, embodying the results of his study of malarial diseases in tropical latitudes. The following synopsis of his theory and conclusions is translated from a published report, as of presumable interest at this time:

EXTRACTS FROM A REPORT IN THE FRANKFURTER ZEITUNG.

Malaria, said the eminent scientist, is the most formidable enemy which we have to encounter, the most serious obstacle to the settlement and development of our colonial possessions in the tropics. We shall never enjoy the possession of our colonies until we have vanquished this disease. The first step toward successful resistance is a thorough, accurate knowledge of its origin and the methods of its dissemination.

Malaria is distributed all over the globe. In its milder forms it is found in this country in the form of swamp fever. It appears in a still more severe type in Mediterranean countries, but worst of all in the tropics. Its most violent and malignant form is the black-water fever (vomito). The exciting cause or germ of malaria in all its forms is unquestionably a parasite in the human blood, which was first discovered and demonstrated by Italian scientists, and the functions of which are now definitely known. It appears as one of the easily recognized rings in the red corpuscles of the blood, which enlarges, splits into fragments, and within a few hours produces more than twenty young parasites, which are distributed among the corpuscles and thus disseminate and extend the infection throughout the blood.

Prof. Koch has succeeded in proving that malaria, in its different stages of development, which are characterized by an intermittently rising and subsiding fever, corresponds exactly with the development of the parasites; so that by examination of the blood the progress and stage of the disease can be definitely ascertained. He has further succeeded in demonstrating the exact moment for the effective administration of quinine, which does not kill the microbe, but definitely checks and limits its power of reproduction. This discovery was highly important, for as a result of it the physician can, with reasonable certainty, provide that the disease shall be cured and not run to a fatal result. Of course, the convalescence may be long and uncertain, for relapses which leave the patient weaker and weaker are liable to occur so long as there remain parasites in the blood. Against them no sanitarium, no elevated location, offers any certain remedy; but it is, on the other hand, a consolation to know that recovery after a case of malaria may be rapid, and that the disease affects the constitution less seriously than other fevers of equal temperature and duration.

Malaria is not contagious. The means of its distribution have been sought for in the air and water, but Koch believes that blood-sucking insects are largely responsible for its dissemination. Wherever mosquitoes exist, malaria will prevail. Where there are no mosquitoes, cases of malarial disease occur only when the infection has been previously received in a malarial locality. The exact relation of mosquitoes to malaria still lacks, however, exact and conclusive scientific demonstration. Analogies are found where blood-sucking insects convey disease germs, as, for instance, the tsetse fly, and especially the Texas fever among cattle, whereas, as is well known, the disease germ is carried by a tick or insect.

No race of man is immune from malarial disease. Negroes living on the coasts of tropical countries are practically so, but negroes of the same race from mountainous districts coming to the coast are susceptible to the fever. The former have, according to the opinion of Dr. Koch, acquired immunity through slight malarial attacks during infancy or youth. But, as there is this naturally produced immunity, it must be possible to produce an artificial one.

On this point Dr. Koch insists that in the case of malarial disease, the exciting cause of which is definitely known, the conditions are much less difficult than in the case of other diseases, the germs of which are not known, as, for instance, hydrophobia and cattle plague (rinderpest), in respect to which a certain degree of immunity has nevertheless been attained.

The first essential step in combating the disease is for the patient to leave immediately the malaria-infected district, and be protected against mosquito bites by prophylactic doses of quinine. Prof. Koch believes that through his studies of malarial disease in the localities where the most intense and virulent forms prevail, the way has been opened to new lines of study, and new limits set to the dangers of the disease itself. He closed his address with these words: "To overcome this malady is equivalent to the peaceful conquest of the most beautiful portions of the globe."

FRANK H. MASON, Consul-General.

Frankfort, June 15, 1898.

The Novoe Vremia, of St. Petersburg, has the following interesting account of emerald mining in Russia: Emeralds, some of which are very fine, are found in the district of Ekaterinburg, along the banks of the Tokova River, about 52 miles from the capital of the district. Mining for this precious stone commenced in 1841, and at the beginning gave very good results. The first emerald was found by a peasant named Maxim Kojevnikow, in 1839, while he was examining the roots of a tree which had been uprooted by a storm. It is pretty certain, however, that discoveries of the same kind had already been made in 1669. It is even possible that finds had been made prior to them, as the Czar Boris Godounow presented the Venetian engraver Francis Ascentini with a sable fur and 100 ducats for having cut a large emerald for a ring. The finest emeralds were found when these stones were being mined for the account of the government. During this period, that is up to 1862, 5,600 poods were extracted. The government afterward farmed out the mines to private parties, who were not successful. The emeralds of superior quality have been found near the surface of the soil, while those found in deep ground were of inferior quality.

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